New York's Coastal Program

NEW YORK STATE DEPARTMENT OF STATE
Division of Coastal Resources and Waterfront Revitalization

# *Hudson River Significant Tidal Habitats:*

A Guide to the Functions, Values and Protection of the River's Natural Resources

COASTAL ZONE
INFORMATION CENTER



New York - Coastal Zone Management Program

Mario M. Cuomo, Governor
Gail S. Shaffer, Secretary of State

The New York State Department of State is a diverse agency which combines modern activities with historic responsibilities. Twelve different program areas reflect the growing role of the agency and its unique ability to act as liaison between state government and the public, and provide a variety of services to New Yorkers. New York's Coastal Program is housed in the Department of State. It oversees the state's 3,200 miles of coast, balancing protection of coastal resources with careful waterfront development.

If you would like additional information on New York's Coastal Program, please write:

Secretary of State Gail S. Shaffer
NYS Department of State
162 Washington Avenue
Albany, New York 12231

# HUDSON RIVER SIGNIFICANT TIDAL HABITATS:

## A Guide to the Functions, Values, and Protection of the River's Natural Resources

*Prepared By:*

New York State Department of State
Division of Coastal Resources and
Waterfront Revitalization

and

The Nature Conservancy



March 1990

*"For all of its pastoral beauty, however, the Hudson is essentially an urban river, dominated by man, his history and his industry. Like all rivers, the Hudson constantly strives to purify itself, but its future destiny for good or ill depends entirely upon the good will of man..."*

William F. Gekle in
The Lower Reaches of the Hudson River
Wyvern House, Poughkeepsie, New York, 1982

Inside cover photograph: View to the south over Constitution Marsh (A. Lillyquist/DOS)

## FOREWORD

This guide presents the results of a special study of the tidal portion of the Hudson River between New York City and Troy. The purpose of this guide is twofold. First, it is hoped that the information it contains will highlight the unique character of the Hudson River Estuary and increase the reader's awareness and understanding of the important natural resource values provided by the system. Secondly, it is hoped that those individuals and the various government agencies and private organizations concerned with future use and protection of the Hudson River's natural resources will take note of the guidelines and recommendations contained in the guide. These and other management actions will need to be taken to ensure the future protection of the Hudson River's natural values.

This guide relies heavily on previously completed documents, studies and maps, as well as field observations based on a number of visits to the River's tidal habitats. The guide builds directly on information developed by the Department of Environmental Conservation for designation of significant coastal fish and wildlife habitats under the State's Coastal Management Program. Most importantly, it incorporates the insights of individuals familiar with the River's natural resources, as well as the problems that affect and are threatening these resources. The guide should be of practical use to public officials, the residents of the River Valley, public agencies, and private organizations in making tangible progress towards more enlightened use and protection of the River's natural resources.

The Hudson River is trying to cleanse itself. Beginning with the colonial period, years of exploitation and abuse led to the loss of eagles from the Hudson Valley, a decline in fish stocks, widespread pollution and contamination of sediments, and the transformation of some parts of the River into an open cesspool during the dry summer months. One of the significant observations that emerged from this study is that people seem to have forgotten that the River reached this low point in its natural history less than twenty years ago. Today, eagles are returning, fish stocks are rebounding, pollution, although still ubiquitous, has declined, and with it, most of the unpleasant summer cesspools have disappeared.

Improvements in the River are, however, accompanied by new threats to its natural resources. Our growing population is once again drawn to the River: waterfront condominiums are claiming the Riverfront and driving real estate prices beyond the reach of public ownership, pleasure boats now fill many tidal creeks, and marina basins are being constructed in tidal shallows. Still, the Hudson River has not been subjected to the same level of frantic and intense development that typifies other sections of New York's coast. Opportunities remain to plan for a balance between use and protection of the River's resources. We already have substantial experience in using the River's resources; in another twenty years, we should be able to claim that we also have experience in protecting these resources. This guide is intended to help provide the initial steps that will eventually justify such a claim.

This guide is the second in a series of natural resource studies initiated by the New York State Department of State through its Division of Coastal Resources and Waterfront Revitalization. As the agency responsible for administering the State's Coastal Management Program, the Department of State is actively involved in the protection of New York's coastal resources from the marine environment of Long Island Sound and Peconic Bay, to the freshwaters of Lakes Erie and Ontario.

## ACKNOWLEDGEMENTS

This guide is the result of a joint effort by the New York State Department of State, Division of Coastal Resources and Waterfront Revitalization (DOS) and The Nature Conservancy (TNC). Preparation of the guide was funded in part by the Office of Ocean and Coastal Resource Management, National Oceanic and Atmospheric Administration, with a grant provided under the Coastal Zone Management Act of 1972, as amended. The Nature Conservancy's field work for preparation of this guide was partially funded by the Zoos, Botanical Gardens and Aquariums Program, which is administered by the New York State Office of Parks, Recreation and Historic Preservation for the Natural Heritage Trust. Additional funding was provided by the Conservancy's Lower Hudson and Eastern New York Chapters, New York Field Office, and the Rodney Johnson Stewardship Endowment.

An early draft of this guide was prepared by Nick Salafsky (TNC) under the direction of project leaders Tom Hart (DOS) and Amy Lester (TNC). Nick was called upon to conduct literature reviews, interviews of people knowledgeable of the River, field investigations and photo-documentation of the River's tidal habitats, and to prepare maps, graphics, and initial drafts of this guide, all in an unreasonably short period of time. Few people could have done as well as he did at these tasks.

The final guide was written and prepared by Tom Hart. Preparation of the Hudson River Habitat Maps was completed with the assistance of Nancy Nugent (DOS). Many versions of this guide were reviewed and edited by Kevin Cross (DOS). Computer support was provided by William Cross (DOS), who made printing this guide possible.

Support and technical assistance were provided by the staff of The Nature Conservancy, NY Field Office. Special thanks are extended to Betsy Blair (Hudson River Estuarine Research Reserve), Bridget Barclay (Clearwater, Inc.), and Robert Zaremba (TNC) for providing extensive and comprehensive comments on draft materials. In addition, the following provided advice on writing the guide or commented on a draft of the document: Tom Rawinski (TNC), Carol Reschke (TNC/Natural Heritage), Nancy Beard (New York State Department of Environmental Conservation, (DEC)), Bryan Swift (DEC), Bob Brandt (DEC), John Ozard (DEC), Paul Neth (DEC), Ken Wich (DEC), Michael Chezick (Fish and Wildlife Service), Mario Del Vicario (Environmental Protection Agency), Len Houston (Army Corps of Engineers), and Michael Ludwig (National Marine Fisheries Service). Original mapping and evaluation of the State's significant coastal fish and wildlife habitats was provided by the Department of Enviornmental Conservation's Significant Habitat Unit.

The following are acknowledged for granting permission to use copyrighted materials:

Boyce Thompson Institute for **Figure 3** taken from *An Atlas of the Biological Resources of the Hudson River Estuary* (Ithaca: Boyce Thompson Institute, 1977).

Clearwater, Inc. for **Figure 22** taken from *A Panoramic View of the Hudson* (Poughkeepsie: Clearwater, Inc., 1979)

E. Kiviat for **Figure 24** taken from *Exotic Plants with Identified Detrimental Impacts on Wildlife Habitats in New York State* (Ithaca: The Wildlife Society, 1987)

R. Malecki for **Figure 26** taken from *Exotic Plants with Identified Detrimental Impacts on Wildlife Habitats in New York State* (Ithaca: The Wildlife Society, 1987)

W. Odum, T. Smith, J. Hoover, and C. McIvor for **Figure 11** taken from *The Ecology of Tidal Freshwater Marshes of the United States East Coast: A Community Profile* (Washington: USF&W, 1984)

S. Rohmann and N. Lilienthal for **Figures 17 and 28** taken from *Tracing a River's Toxic Pollution: A Case Study of the Hudson, Phase II* (New York: Inform, 1987).

R. Tiner for **Figures 2 and 4** taken from *A Field Guide to Coastal Wetland Plants of the Northeastern United States* (Amherst: U. of Mass. Press, 1987).

Also acknowledged for their contributions are: Anne Williams, previously of The Nature Conservancy, Eastern New York Chapter, who provided the base map of the Hudson River that appears in the Introduction and Chapter 6; and, Kate Hubbs (TNC), Alan Lillyquist (DOS), Nancy Nugent (DOS), Harry Dodson (Dodson Associates) and Steven Stanne (Clearwater) who contributed photos as credited.

## CONTENTS

# LIST OF FIGURES

## INTRODUCTION

Among tidal estuaries of the northeastern United States, the Hudson River is of great importance for both ecological and economic reasons. Although the River has undergone centuries of interaction with surrounding human populations, it has sustained less ecological damage than many other rivers in the region, which have been dammed, diverted, and otherwise altered. Accordingly, the Hudson supports many tidally-dependent plant and animal communities that at one time were much more abundant in the Northeast and even the world. The Hudson is a major component of the ocean ecosystem along the Atlantic seaboard, supplying nutrients to and supporting a rich variety of estuarine life. As a spawning and nursery ground for ocean fish in the rich Atlantic fishery, the Hudson River estuary is rivaled only by Chesapeake Bay, which, in recent years, has suffered severe declines in some of its fish populations.

In economic terms, the Hudson has been among the most important commercial rivers in the United States. The prosperity of New York State and the nation has been linked to the Hudson principally as a means of transportation and for the natural resources of the River and its surrounding valley. Ultimately, the large human population that now depends upon the River will best be able to maintain this prosperity by forming a new partnership with the River.

### Purpose of This Natural Resources Guide

The purpose of this natural resources guide is to help facilitate this partnership with the River by providing information to illustrate values of the Hudson's natural resources and to propose measures that may be helpful in protecting these natural values. Much of what is contained in this guide builds on efforts of the State's Significant Coastal Fish and Wildlife Program, which is administered by the Department of State through the State's Coastal Management Program. Most of the natural areas described in Chapter 6 are State-designated significant coastal habitats. Additional information documenting recognized natural values of these areas is available in narrative form at the Departments of Environmental Conservation and State and at town and county clerks' offices. The New York Natural Heritage Program, a joint effort of the Department of Environmental Conservation and The Nature Conservancy, is an additional source of ecological information on the Hudson River.

This guide describes the Significant Coastal Fish and Wildlife Habitats of the Hudson River from Troy to the New York City municipal boundary (see Figure 1), excluding the portion of the Hudson between New York and New

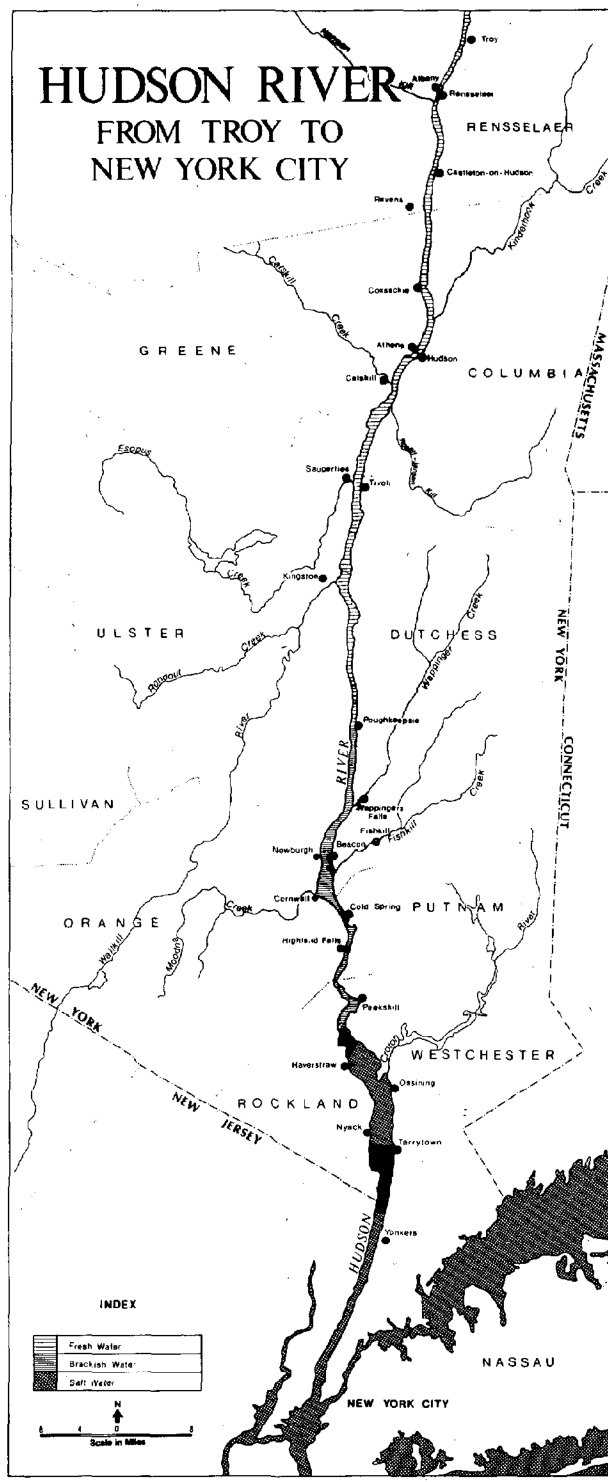



**Figure 1**: *The Hudson, from Troy to New York City*

Jersey. The geographic coverage of this guide does not imply that habitats in the excluded portion of the Hudson and New York - New Jersey Harbor are any less important than those found in upper portions of the estuary. In fact, these lower estuary habitats are currently the subject of substantial attention. The value of the habitats in the New York City area, in conjunction with the variety of large-scale development proposals being considered for these areas, presents an entirely different set of management issues and requirements. The value of these habitats, and the potential threats to their continued viability, more than justify the need for a separate guide to their values and management.

This guide is an ecological primer containing general and site specific information about tidal habitats of the River, which can be used by local authorities and others interested in planning for the future of "their" section of the River. Through its use, those who have limited scientific backgrounds will be better able to understand the complex nature of the River ecosystem and actively participate in management decisions concerning the River. The broad scope of this guide, coupled with the detailed habitat information it contains, also makes it a convenient reference source for professionals in many fields who are concerned with protection and management of the River's resources.

Efforts have been made to make the content of the guide both useful to the professional and interesting to the casual reader. While no attempt has ben made to avoid presenting complex ecological information, most scientific terms are explained upon their first use. English units of measurement and common species names are used throughout. More importantly, concepts and hypotheses that have not been scientifically validated are deliberately presented in an effort to spur interest in alternative ways of thinking about and protecting the River.

Historically, effective protection and management of the Hudson's natural resources has been difficult; few people recognize its resource values and even fewer understand what protection can be provided. It is the rare individual who has both a sufficient grasp of underlying ecological relationships and the ability to explain convincingly the need for specific habitat protection measures. Although many important texts have been written about the Hudson River, this guide was designed specifically to fill the need for an ecologically-oriented approach to protecting the natural resources of the River. As such, this guide emphasizes functions of ecological components of the habitats as they relate to the overall River system.

## Structure of the Guide

The guide has four parts, each of which presents a different perspective of the River.

### The Natural Ecosystem

The first three chapters provide an overview of the River as a natural ecosystem. *Chapter 1: Ecological Community Descriptions,* examines the ecology of tidal communities, looking at both biological and physical components of the system. For each community type, individual components are described and a summary of the community is provided. *Chapter 2: Biology of Rare and Important Species,* presents plant and animal species of interest from commercial or conservation perspectives and briefly describes significant aspects of their life cycles, habitat requirements, and Hudson River populations. *Chapter 3: The River as an Ecosystem,* views the River from an ecosystem perspective, synthesizing habitat and species information from previous chapters into a larger picture.

### Human Impacts on the River

The next two chapters present an overview of human activities along the River. *Chapter 4: Human Interactions with the River Ecosystem,* examines effects of past and present human activities on River habitats. *Chapter 5: Existing Responsibilities for Resource Management,* looks at public agencies and private organizations that are concerned with human use of the River.

### Significant Tidal Habitats

*Chapter 6: Site Specific Information,* constitutes most of the guide and examines 39 significant habitat sites along the River. Information provided for each site includes a description of important biological and cultural features and a map identifying locations of examples of these features. Ecological explanations for components of each site are not provided; the reader may refer to introductory explanations in Chapters 1-5 or use the *Further Readings* sections that appear in each chapter to locate more detailed information.

### The Future of the Hudson River

A recurring concept encountered during the preparation of this guide is the complexity of the River ecosystem; the interwoven character of its human and natural components suggests that there are no easy solutions to the problems caused by their interactions that will satisfy all involved parties. These issues are briefly discussed in *Chapter 7, The Future of the River,* where a philosophy for making progress toward the goal of ensuring the future value of the Hudson River's tidal habitats is presented.

## Chapter 1

# ECOLOGICAL COMMUNITY DESCRIPTIONS

*This chapter describes ecological community types found along tidal portions of the Hudson River. The first section summarizes general environmental characteristics of the River ecosystem. Subsequent sections describe plant composition, animals, physical environment, and identification of the tidal communities, including:*

- *Deepwater*
- *Shallows, Mudflats, and Shore*
- *Tidal Marsh*
- *Tidal Swamp*
- *Freshwater Creek and Upland Forest*

## 1.1 General Environmental Characteristics

Areas along the atlantic coast of the U.S. that have freshwater tidal wetlands and littoral zones comparable to those in the Hudson River range from Massachusetts to Georgia. These sites have a major influx of freshwater and a daily tidal pattern that is enhanced by constriction of upper portions of the estuary (Odum et al., 1984). In the Hudson estuary, the dominant environmental feature is a four-foot-high tidal flow. The full cycle of this flow, which occurs roughly twice a day, creates a complex intermixing of water and nutrients from the River, its tributaries, and the ocean. Other important environmental factors affecting tidal habitats in the Hudson River are regional climatology and underlying geology.

### Hydrology

Although energy of the tidal flow in the Hudson is derived from ocean tides, not all of the tidal portion of the River, which extends from the Battery in Manhattan to the federal dam at Troy, is saltwater. A salinity gradient exists within the estuary with salt levels ranging from greater than 30 parts per thousand (ppt) at Manhattan to less than 0.5 ppt at Troy (Figure 2). As described in the Boyce Thompson Institute's Atlas of the Biological Resources of the Hudson Estuary (1977), water from the River and ocean mix in a region known as the "salt front." Because of its lower density, freshwater floats above saltwater, creating an underlying salt wedge. Tides observed in freshwater portions of the estuary are a result of oceanic tidal energy which forces this salt wedge upriver and reverses direction of the River's flow. Along with affecting the River's flow, tides create friction between the layers of freshwater and saltwater, producing internal waves that result in an oscillatory mixing of water. Turbulence created by these movements, in combination with salinity gradients, creates a "nutrient trap" which retains water-borne nutrients within the estuary and greatly enhances the River's productivity.

In addition to daily tidal movements, the salt front also moves north and south with the seasons. During spring snowmelt, large volumes of freshwater may push the salt front south as far as the Tappan Zee Bridge; during summer low water flow, brackish water has been recorded as far north as Poughkeepsie. The volume of freshwater entering the system depends on hydrological patterns of the entire 13,030-square-mile Hudson Valley watershed (Figure 3), which are determined by precipitation, groundwater flow, and dams (Malcolm Pirnie, Inc., 1983). In comparison with the tidal flow observed in the River (both upstream and downstream), freshwater flow (net downstream flow) accounts for less than 10% of the total flow. The differences in tidal and freshwater flow volumes dramatically illustrate the dominance of tides in the Hudson estuary.

Seasonal variations in amounts of freshwater input and heights of tides determine the degree of flooding of habitats in and along the River. The estuary may be divided into three hydrological zones: a subtidal zone that is inundated permanently; a regularly flooded zone that is submerged twice daily; and an irregularly flooded zone that is under water only occasionally during the course of the year (Figure 4). These hydrological zones provide, in part, the physical basis for the ecological communities described in this chapter.

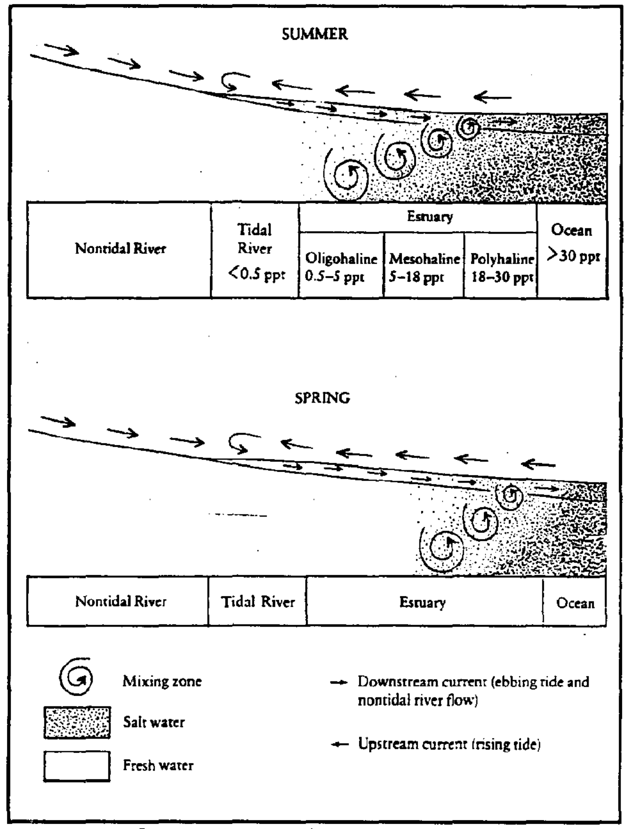



**Figure 2:** *Generalized salinity and current patterns for the Hudson Estuary (from Tiner, 1987).*

### Climate

Climate in the estuarine portion of the River is the product of coastal and inland weather systems. The Hudson River Valley has moderately cold winters and warm, humid summers. Kiviat (1978) lists the average precipitation in Dutchess County (near the mid-point of the estuary) at 40.1 inches annually, distributed fairly evenly throughout the year. The average growing season in Dutchess County is 155 days, and average air temperatures are 23 - 29 °F in January and 71 - 73 °F in July. In general, the River moderates the climate of adjacent shore areas, which are cooler in summer and warmer in winter than surrounding uplands.

### Geology

Productivity of the Hudson is related to the nature of rock and soil formations in the surrounding watershed and on the geologic forces that formed the estuary. Today's

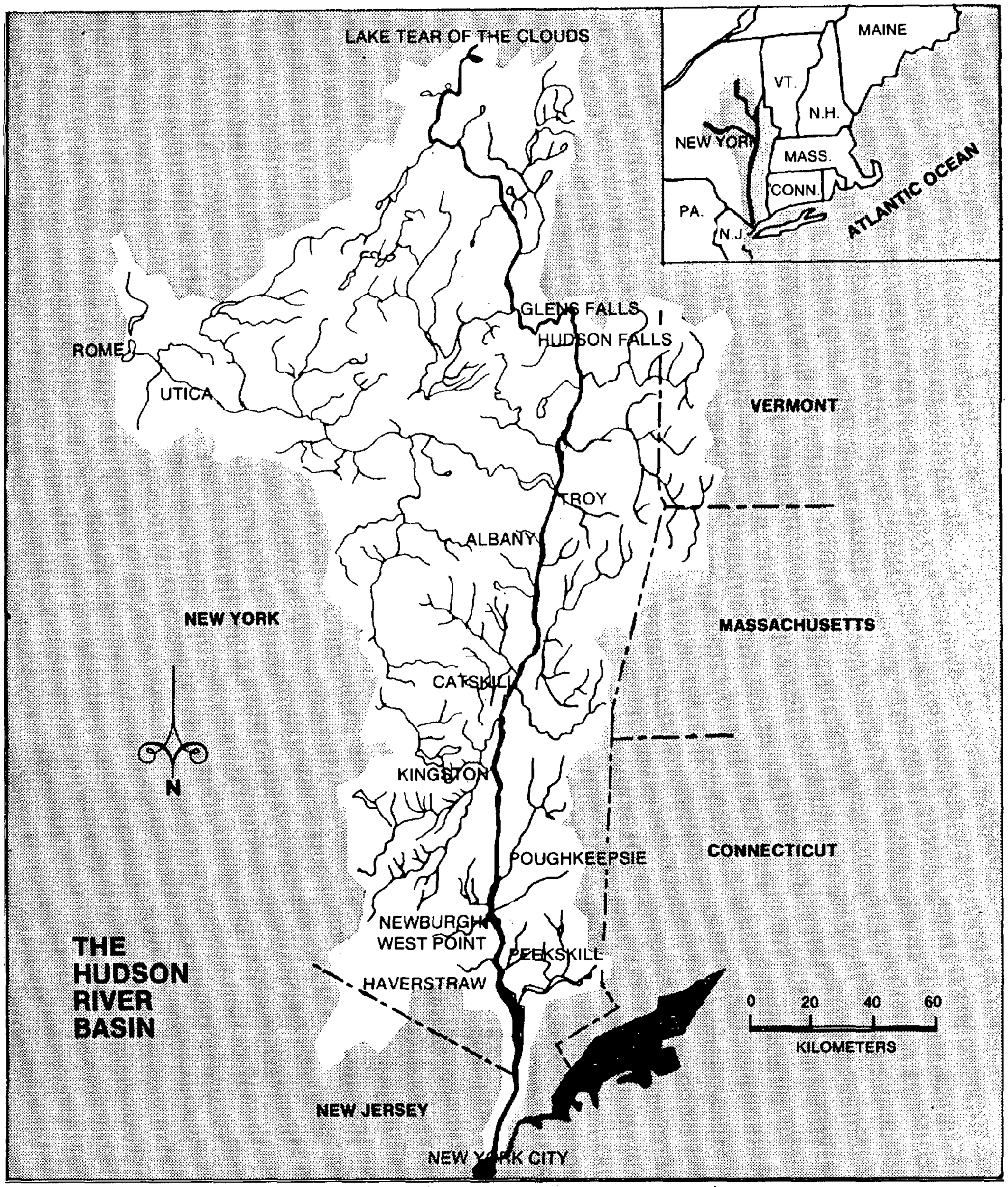



**Figure 3:** The Hudson River's watershed (from Boyce Thompson, 1977)

Hudson Estuary had its origins in the last glaciation, when the Wisconsin ice sheet deepened the River through physical scouring (with the advance of ice) and by water flow from the combined Great Lakes and Champlain basins. The Lower Hudson Valley and Long Island Sound became a freshwater lake, impounded by large glacial moraines left behind by the waning ice age. The estuary was created when the morainal dam at Verrazano Narrows was breached nearly 13,000 years ago, allowing ocean waters to flood the deep valley. Rising sea level and erosion-based sedimentation have resulted in today's Hudson Estuary (Boyce Thompson, 1977).

Bedrock exposed by glaciers consists of Ordovician shales and sandstones (with minor amounts of conglomerate, mudstone, limestone, and slate) in upper portions of the estuary; and Ordovician gneisses, marbles, schists, sandstones, and shales in more southern regions

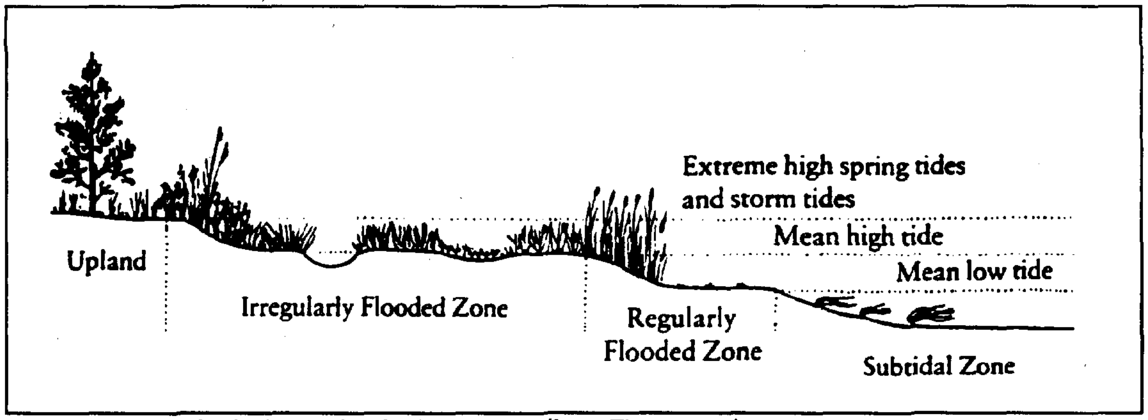



**Figure 4:** Hydrological zonation in the estuary (from Tiner, 1987)

(NYS Museum and Science Service, 1970; Malcolm Pirnie, Inc., 1983). These rocks are resistant to erosion and provide little nutrient input to the River (Odum et al., 1984). However, many nutrients are provided from surrounding lands, which are covered with a variety of fertile soils resulting from deposition of glacial till and outwash and accumulated alluvial (river) and lacustrine (lake) sediments.

## 1.2 Ecological Communities

In the following sections, a number of distinct *ecological communities* are described, each with its own particular floral and faunal components, and environmental characteristics. In this guide, the term "community" is defined as an assemblage of populations living in an environment and interacting with one another to form a distinctive living system (Whittaker, 1975; Reschke,1988). These living systems or communities occur repeatedly throughout the River ecosystem and can be identified by characteristic plant or animal species or by the physical environment that they tend to occupy.

The community is an essential concept in the science of ecology; however, it also imposes an artificial structure on a complex natural system. Applying the concept of community to the real world is often thwarted by natural variability and the surprises that are always inherent in dealing with living systems. For example, locating an exact boundary between communities is often difficult because communities form a gradient from the bottom of the River to the upland shore. Plants that dominate one area are often found in a subsidiary role in adjacent areas, and animals readily travel back and forth between areas. Nonetheless, dividing the ecosystem into communities is a useful way to understand the functional relationships among different parts of the Hudson River ecosystem.

Each of the following sections first describes a community according to the physical environment that it tends to occupy. Equivalent community names are provided to correlate the information in this guide with the State-wide inventory and classification efforts of the New York Natural Heritage Program. Examples of important animals and plants that live in each community are discussed, followed by a description of the environmental conditions characteristic of the community. Each section concludes with a summary to facilitate identification of the community on the River.

## 1.3 Deepwater

The deepwater community includes sections of the River with water depths greater than six feet at low tide. Deepwater community is equivalent to the *tidal river* community recognized by the New York Natural Heritage Program (Reschke, 1988).

***Plants of the Deepwater Community***

The only vegetation growing in deepwater community is phytoplankton in upper layers of the water column. Light generally does not penetrate deep enough to support photosynthesis of rooted plants in this community.

***Animals of the Deepwater Community***

The deepwater community supports abundant animal life which is sustained by organic material originating in the watershed and adjacent productive areas. The animals of the deepwater community can be grouped in three different categories based on their roles in the ecosystem.

**Benthic Invertebrates**

Bottom-dwelling or *benthic* animals, as their name implies, live in or on the bottom of the River where they feed on organic detritus and other animals. The benthic community can be subdivided based on sizes of component organisms. Common microbenthic animals include hydras, amoebas, foraminifera, and bacteria (Odum et al., 1984). Macrobenthic animals can be further divided into three functional groups, based on their body shapes and modes of living. One group is composed of wormlike animals that burrow in the mud, including rhynchocoels, roundworms, bristleworms, water earthworms, and leeches (Boyce Thompson Institute, 1977). Another group is composed largely of hard-shelled mollusks that feed either on suspended materials filtered from the water (clams and mussels) or on residue scraped from exposed surfaces (snails). The third major group of macrobenthic invertebrates is comprised of arthropods, which includes insect, barnacle, shrimp, isopod, amphi-pod, and crab species (Boyce Thompson Institute, 1977).

Local distributions of these species reflect differing patterns of salinity, currents, oxygen levels, and temperatures. Compared with marine and non-tidal areas, there is a low diversity of microhabitats in freshwater tidal systems, which is accompanied by lower species diversity. Nonetheless, studies in various estuaries have found between 49 and 69 macrobenthic species in tidal areas (Koss et al., 1974, and Diaz, 1977 in Odum et al., 1984). Adult forms of most benthic species are indicators of environmental conditions in the River, since their limited motility prevents them from moving away from pollutants. If the environment changes beyond an animal's physiological tolerance, it dies.

**Fish**

Fish communities within tidal waters of the Hudson can be subdivided into five groups based on utilization of different portions of the River for various parts of their lifecycles (Boyce Thompson Institute, 1977; Odum et al., 1984). *Resident freshwater* fish (e.g. perch, catfish, shiners, bass, and sunfish) spend their entire lives in freshwater of the upper estuary, while *resident estuarine* species (e.g. hogchokers, banded killifish, mummichogs, and bay anchovies) spend their lives in brackish waters of the lower estuary. Both types generally inhabit shallow areas of the River and its tributaries and are discussed further in the "shallows, mudflats, and shore communities" section.

*Anadromous* fish are species that spend most of their adult lives in the ocean and return to fresh water only to spawn. After eggs hatch, larvae and juveniles feed and grow in "nursery grounds" in the estuary before returning to the ocean to complete their life cycles. Examples of anadromous fish that can be found in the Hudson deepwater community include American shad, blueback herring, alewife, striped bass, Atlantic tomcod, and Atlantic and shortnose sturgeons (see Chapter 2 for more detailed information about individual species). *Catadromous* fish are species that live in freshwater and migrate to the ocean to spawn; the only example from the Hudson River is the American eel. Finally, *marine* fish are ocean species that live primarily in saltwater but will, on occasion, use the estuary as a feeding or nursery ground. Examples of marine fish found in the Hudson include menhaden, American goosefish, bluefish, weakfish, and sculpins (Boyce Thompson Institute, 1977).

**Fish-eating Predators**

The last group of animals included in the deepwater community are those that prey on fish living in the deepwater community. These predators do not live in deepwater but depend on it as a source of food. Raptors (e.g. bald eagles and ospreys) capture fish near the water's surface; diving birds (cormorants, loons and fish-eating ducks) descend after their prey; and humans employ a variety of techniques to land their catch.

### *Physical Environment Characteristics*

A complex physical environment with many factors affecting animal distributions is associated with the deepwater community.

**Hydrological Features**

Water flow in deepwater is largely controlled by tides, although it is also affected by seasonal floods, storms, and winds. Factors that influence animal distributions in deepwater habitat are depth, light, turbidity, temperature, salinity, and oxygen, nutrient, and pollutant levels.

*Turbidity* refers to the amount of suspended sediment in water. Turbid water clogs gills and digestive organs of fish and other aquatic organisms, discouraging their use of these areas. Many animals are restricted to a certain *temperature* range. Warm water contains less dissolved oxygen than cold water, preventing use by species with higher oxygen demands. *Salinity* also affects which animals can be found in sections of the River. Many species are restricted to either the brackish or freshwater portions of the River, and even anadromous fish, which migrate from one environment to another, often have to wait at the salt front while adjusting to new salinity levels. Deep troughs contain pockets of higher salinity, denser water, which may account for the occasional presence of marine species far north of the salt front.

*Oxygen, nutrient, and pollutant* levels also affect animals' use of deepwater. The amount of dissolved oxygen in water is dependent on a number of factors, including water temperature, and the degree to which water is mixed with the atmosphere. Nutrient loads can also affect oxygen content. When a limiting nutrient becomes available, algae undergo a population explosion, resulting in "blooms". Dead and dying algae provide the food source which drives a secondary population explosion of "decomposer bacteria." During the decomposition process, the bacteria consume dissolved oxygen in the water, killing many animals that are sensitive to low oxygen levels. Finally, concentrations of pollutants can affect water quality to the extent that reproductive capabilities of some animals are hindered. The effects of pollutants are most notable on the fish-eating predators at the top of the food chain such as ospreys, eagles and even humans.

**Geological Features**
Bottom sediments of deepwater areas vary from rocky or gravelly substrates to layers of sand, silt, and fine muck. Sources of sediment include runoff from tributary streams, riverbank erosion, airborne particles, and human activities. As the lowest level in the drainage basin, deepwater areas are subject to heavy accumulations of sediment, although this is limited in some places by the flushing action of tidal currents. The type of substrate found at any given site is important in determining types of benthic animals that can live there, as well as its suitability as a spawning ground for various fish. Sedimentation processes are also important in limiting toxic chemical distribution and effects by sequestering toxins in the bottom sediments.

**Figure 5:** A deepwater area near Germantown (N. Salafsky/TNC)

*Deepwater Identification*

The deepwater community is located at or near the center of the River, wherever water is greater than 6 feet deep at low tide (Figure 5). Because of the expense and difficulty of remote methods of investigation and measurement, relatively little is known about this portion of the River, including bottom contours, sedimentation rates and patterns, sediment flow, and salt front dynamics. Most of the animal use information is based on research sampling programs associated with the utilities' power plants or through commercial fishery statistics.

## 1.4 Shallows, Mudflats, and Shore

Shallows, mudflats, and shore communities include sections of the River located near low tide mark. These communities are roughly equivalent to the brackish and freshwater types of *subtidal aquatic bed, intertidal mudflat,* and *intertidal shore* communities recognized by the New York Natural Heritage Program (Reschke, 1988).

*Shallows* are always below low tide mark; *mudflats* are barely exposed at low tide; and the *shore* is a zone largely exposed at low tide but inundated at high tide. These three communities are found not only along the River proper, but also extend along tidal portions of tributary streams and marsh drainage channels. In general, each of these areas supports distinct plant and animal populations.

*Plants of the Shallows, Mudflats, and Shore*

**Shallows**
Shallows support plants adapted to an aquatic environment either directly in the River, or in its tributary streams. Most vascular plants in this zone are rooted in the bottom and are exposed to air only during periods of low tide, if at all (Figure 6). Representative freshwater species include waterweed, water celery (tapegrass), naiads, various pondweeds, and the exotic Eurasian water-milfoil and water chestnut (Tiner, 1987; Reschke, 1988). These plants characteristically have long narrow leaves that completely shade the bottom of the River or creek and tend to move with the currents, so that they point in the direction of the water flow. In more brackish sections, common plants include widgeon grass, water celery, sago pondweed, and horned pondweed (Reschke, 1988).

In addition to vascular plants rooted in the bottom, numerous smaller plants are free-floating, either in the water column or on its surface. Surface plants are usually duckweeds or waterchestnut. Plants in the water column are largely single-celled or multi-cellular colonies of phytoplankton, including species of green and blue-green algae, diatoms, and dinoflagellates (Odum et al., 1984). These single-celled plants are usually not visible to the naked eye but are an important component of the ecosystem since their photosynthetic activity supports a portion of the food web within the River.

**Figure 6:** *Shallows at Esopus Estuary (N. Salafsky/TNC)*

### Mudflats

Mudflats support plants adapted to being submerged for most of the day, then briefly exposed at low tide when they are typically found encrusted in mud. In general, these plants thrive on large, level, open areas, although they can be found in narrow strips between shallows and lower marshes or interspersed among plants of lower marshes (Figure 7). Common mudflats species form small rosettes a few inches high and include strap-leaf arrowhead, mud-plantain, grass-leaf arrowhead, and goldenclub (Reschke, 1988). More brackish mudflats contain spongy arrowhead, strap-leaf arrowhead, mudwort, and tapegrass. In addition to vascular species, mudflats support significant numbers of periphyton (attached algae) and bacteria that grow on mud or surfaces of vascular plants. One New Jersey study found 84 species of periphyton (exclusive of diatoms) present in the mudflats sediment (Whigham et al., 1980 *in* Odum et al., 1984). Bacteria of the mudflats play an important ecological role by breaking down rich organic matter produced in adjacent marshes or the watershed.

### Shore

Shore areas are found along rocky or gravelly banks where extensive marshes or swamps are absent. Vegetation along the shore is sparse, and the substrate is exposed to air for most of the tidal cycle (Figure 8). Plants in this community are adapted to an exposed, harsh environment that is subject to waves, ice-scour and upland erosion. Common plants include water-hemp, smartweed, cardinal flower, and Pennsylvania bittercress (Reschke, 1988). Various types of attached algae grow on rocks along the shore.

## *Animals of the Shallows, Mudflats, and Shore*

Calm waters in shallows and mudflats support a wide range of feeding and breeding animals. The drier and less protected shore supports fewer aquatic species, but it is an important area for terrestrial organisms.

### Feeding

Abundant aquatic plants and phytoplankton in shallow waters form the basis of a complex food web linking many animal species. Many animals that feed on phytoplankton and detritus from vascular plants are microscopic animals, collectively termed *zooplankton*. Numbers and species of zooplankton vary greatly with the seasons and include many types of copepods, rotifers, cladocerans, amphipods, and mysids (Odum et al., 1984). Larger animals that feed on aquatic plants include some duck, turtle, and mammalian species.

Zooplankton are the direct food source for many free-swimming fish and fish larvae, which, in turn, are consumed by other species. Many adult fish in shallow water are full-time River residents, including shiners, carp, white catfish, suckers, white and yellow perch, bass, sunfishes, and darters in freshwater regions; and bay anchovies, killifish, silversides, winter flounder, and hogchokers in more brackish sections (Boyce Thompson, 1977). Many anadromous fish described in the section on the deepwater community feed extensively in shallows while preparing to return to the ocean. All three categories of benthic animals previously described for the deepwater community also live and feed in shallows.

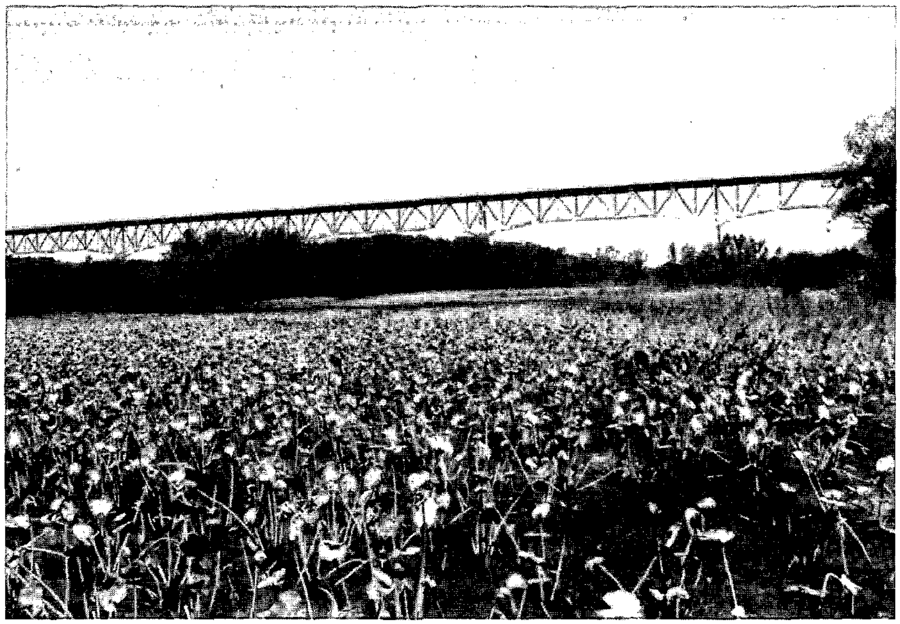


**Figure 7:** *Mudflats interspersed within lower marsh (N. Salafsky/TNC)*

**Figure 8:** *Rocky shore at Stuyvesant Marshes (N. Salafsky/TNC)*

Many bird species at the top of the food chain feed in shallows and mudflats. Great blue and green herons, great egrets, and least and American bitterns feed on small fish, frogs, crayfish, and even small mammals. Floating and diving waterfowl that feed on aquatic plants or small fish and animals of mudflats and shallows include swans, cormorants, grebes, gannets, Canada geese, brant, dabbling and diving ducks, mergansers, and gallinules; king and Virginia rails; kildeer; semi-palmated, lesser golden, and black-bellied plovers; and a host of different sandpipers which feed on seeds, insects, and aquatic invertebrates inhabiting mudflats, shallows, and marshes (Odum et al., 1984; Peterson, 1980).

**Figure 9:** *Mudflat showing thick substrate and surface patterns created by flowing water (N. Salafsky/TNC).*

**Breeding**
Since mudflats and shore alternate between being wet and dry, and provide little cover, they are not used for breeding by many animals. Shallows, however, are a primary spawning ground for many fish and aquatic species. Golden and spottail shiners, silvery minnows, tessellated darters, tidewater silversides, and white and yellow perch use shallows of the River and its tributary streams for spawning (Boyce Thompson Institute, 1977; Odum et al., 1984; Smith, 1985). These fish require clear waters and fast-moving currents to provide adequate oxygen levels for their eggs and larvae. Many anadromous fish spawn in creeks and shallows. Shallows also serve as nursery grounds for the majority of newly hatched larvae and juveniles of both resident and anadromous fish.

Shallows are also important breeding areas for a wide range of invertebrate species. Many species of craneflies, mosquitoes, midges, flies, dragonflies, caddisflies, beetles, and bugs undergo a larval or nymph phase in the water. During this time, these species form a link in the aquatic food chain, feeding on plankton and detritus and being preyed upon by adult and juvenile fish and birds (Boyce Thompson Institute, 1977; Odum et al., 1984).

### *Physical Environment Characteristics*

Shallows, mudflats, and shore areas are dominated by tides and composition of the substrate.

**Hydrological Features**
Water flow in shallows, mudflats, and shore areas on the River is largely controlled by tides, which raise and lower water levels in shallows and alternately expose and inundate mudflats and shore areas, depositing and removing nutrients. This tidal pattern extends to shallows and mudflats along tributary streams where each stream acts as a miniature of the River. Tidal ebb flow starts at the tributary mouth and slowly moves upstream, resulting in a lag of up to several hours between low tide at the River and low tide at the upstream limit of tidal flow in the tributary. The degree of influence of tidal flow in a stream also depends on the volume of water entering from the stream's watershed. As in the River itself, tidal waters reach further upstream in summer than in spring, during snow melt. The dynamic nature of the River's hydrology plays an important role in determining which plants and animals are able to survive in shallows and mudflats.

**Geological Features**
Substrates of shallows and mudflats generally consist of thick layers of mud containing many organic and mineral nutrients (Figure 9). In parts of the River, muddy substrates give way to sand, which appears to support fewer plants and animals. Active erosion in a river or stream occurs at the "thalweg," the channel running parallel to the banks that contains the fastest moving waters. The thalweg has a firmer substrate than the slower moving water in side areas where sediment deposition is taking place. Mudflats and shallows form in these side areas, away from the fast-moving water. Substrate deposition is enhanced on broad and level expanses of mudflats and shallows, which have significant quantities of rooted vegetation that trap and catch sediments by slowing current velocities.

Geology of the shore is quite different from that of shallows and mudflats. The rocky, gravelly or sandy nature of shores is the result of continuous tidal erosion of sediments, which gradually removes smaller particles and leaves larger rocks and pebbles exposed. Shore communities generally occur along parts of the River or its tributaries that are directly adjacent to elevated upland areas where mudflats or marshes have not formed. Artificial shore zones can be found along bulkheads and riprap. In almost all cases, the shore zone is a few yards wide at most, occurring in a strip between high and low tide along steeply sloping shore banks.

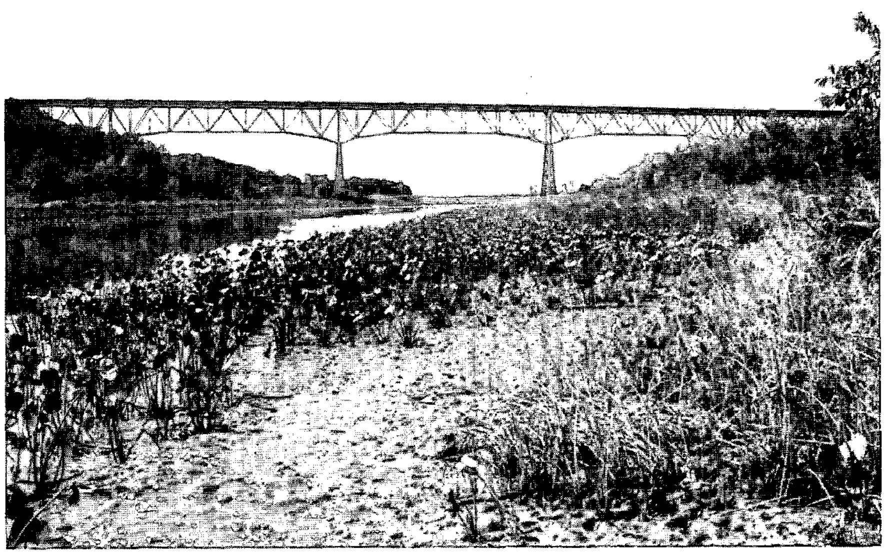


**Figure 10:** Broad-leaved plants of the lower marsh at Roger's Island (N. Salafsky/TNC)

*Shallows, Mudflats, and Shore Identification*

Tidal shallows, mudflats, and shore areas form along edges of the River and tributary creeks near low tide mark. Shallows are muddy or sandy areas covered by a few inches to six feet of water, usually containing large patches of rooted aquatic vegetation. Mudflats are large open areas of thick, bare mud exposed at low tide and often having colonies of small plants that resemble a mown lawn. Shore areas are narrow strips of rocky, gravelly, or sandy beach between low and high tide marks, where river or creek banks rise rapidly to uplands. Shallows, mudflats, and shores can be surveyed on foot at low tide or by canoe at high tide (consult tide tables for daily tide times).

## 1.5 Tidal Marsh

The *tidal marsh* community includes sections of the River where tidal waters inundate plants specifically adapted to daily flooding. A *lower marsh* is defined by species adapted to complete submersion daily, and an *upper marsh* by plant species adapted to partial flooding. Taken together, these two communities comprise the freshwater and brackish *tidal marsh* communities recognized by the New York Natural Heritage Program (Reschke, 1988).

*Plants of the Tidal Marsh*

Within the tidal marsh community, *lower* marsh, which is partially to completely submerged during each tidal cycle, and *upper* marsh, which is dry to partially submerged during the course of a day, correspond to their functional equivalents in tidal salt marshes, which contain "low" and "high" marsh areas (Odum et al., 1984). The lower marsh extends into the upper marsh along drainage channels, and distinctions between the two depend more on community structure than physical location within the site. In comparison with upper marshes, lower marshes tend to have less complex community structure and contain fewer plant species.

**Lower Marsh**

Lower marshes typically contain plants adapted to large daily fluctuations in water levels. In freshwater areas, dominant plants have *broad leaves* rising on long stalks from the base of the plant (Figure 10). The most common broad-leaved plant is spatterdock, typically the first large plant encountered when moving from water toward land (Figure 11). Spatterdock forms homogeneous stands nearest deep water. As distance from deep water increases, spatterdock stands become interspersed with other species, including pickerelweed, big-leaved arrowhead, and arrow arum. In addition to these broad-leaved species, other plants of the lower marsh include wild rice, three-square bulrush, river bulrush, northern water plantain, and mud plantain. In general, the broad-leaved plants form a continuous low canopy one to three feet tall, with wild rice and rushes emerging above and plantains growing below this low canopy.

On sandier substrates, three-square bulrush grows either in homogeneous stands or mixed with water smartweeds and bur-marigolds (Figure 12). Three-square bulrush occupies sandy lower marshes in both fresh and brackish water, while in regions of higher salinity, smooth cordgrass becomes prevalent.

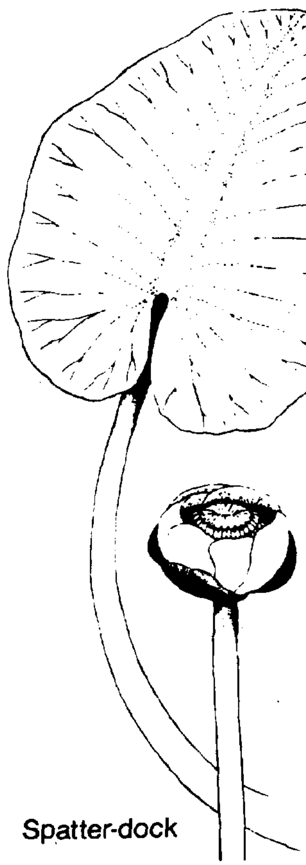



**Figure 11:** Spatterdock, a common broad-leaved plant of the lower marsh (from Odum et al., 1984)

**Upper Marsh**
Upper marshes contain plants that undergo partial flooding during the tidal cycle so they are seldom or never completely submerged. Whereas the lower marsh is characterized by broad-leaved plants, the upper marsh has a *grassy* appearance due to the presence of many narrow-leaved, erect plants. The most common species are narrow-leaved cattail and common reed, both of which form large stands in drier areas. As the ground becomes wetter, cattails are joined by other grassy species, including wild rice, rice cut grass, river bulrush, and sweet flag. Other characteristic plants are jewelweed, bur-marigold, common dodder, purple loosestrife, and water smartweed. In upper marshes, the canopy structure is difficult to describe, but in general, grassy plants form a distinct layer with occasional woody shrubs emerging above and smaller broad-leaved plants below. In brackish water, narrow-leaved cattail, common reed, salt marsh bulrush, and marsh fern are the most common species.

Although both purple loosestrife and common reed are very common, neither are native to Hudson River wetlands. Large homogeneous stands of common reed quickly become established in freshwater, brackish, and salt marshes where vegetation and soils have been physically altered by direct action or by upland erosion and subsequent sedimentation.

### *Animals of the Tidal Marsh*

Tidal marshes provide critical feeding and breeding areas for many aquatic and terrestrial animals. Some are transients, using marshes for feeding or resting during seasonal migrations, while others spend their entire lives in the marsh.

**Feeding**
Tidal marshes are among the most ecologically productive areas in the world (Odum et al., 1984) and the numbers of animal species directly or indirectly dependent on tidal marshes for food supply are astounding. For example, in a study at six freshwater tidal marshes on the Hudson, Swift (1987) observed 69 bird species, while in New Jersey, Tiner (1986) found 120 bird species in a marsh. Foraging methods vary from large flocks of red-wing blackbirds feasting on stands of wild rice to solitary northern harriers (marsh hawks), which spend much of their time in the marsh hunting for small animals.

Terrestrial animals that feed in the marsh include raccoons, which forage for crustaceans and other invertebrates, snapping turtles, which lie in wait for fish, and herbivorous insects that graze on leaves of marsh plants. Although fish are absent from most marshes at low tide, marshes become important feeding areas at high tide. Fish found feeding among the plants of the lower marsh include banded killifish, tessellated darters, mummichogs, sunfish, and carp. Invertebrates including cladocerans, copepods, ostracods, and chironomid larvae are important prey for these fish (Richard and Schmidt, 1986; Duryea and Schmidt, 1986).

**Breeding**
Birds are the most visible (and audible) breeders in marshes. Swift (1987) found 22 species that were confirmed or likely to be nesting in tidal marshes at six sites along the river. Common species included marsh wrens, red-winged blackbirds, swamp sparrows, Virginia rails, yellow warblers, song sparrows, willow flycatchers, common yellowthroats, least bitterns, and American goldfinches; less frequently encountered species included mute swans, mallards, black ducks, wood ducks, green-backed herons, American bitterns, spotted sandpipers,

**Figure 12:** *Three-square bulrush stand on sandflats at Stockport Middle Ground (N. Salafsky/TNC)*

**Figure 13:** *Grassy upper marsh at Stockport (N. Salafsky/TNC)*

common snipes, belted kingfishers, eastern kingbirds, grey catbirds, and common grackles. A similar study in New Jersey found 48 species of nesting birds in the tidal marsh zone (Hawkins and Leck, 1977).

Hudson River tidal marshes also support large populations of nesting birds (as opposed to numbers of species); the average density of breeding birds was about 410 pairs per 100 acres, among the highest densities of breeding marsh birds worldwide (Swift, 1987).

Several fish species, including banded killifish, mummichogs, bluegills, pumpkinseed, carp, and black bass, use lower marshes as spawning or nursery grounds. Many amphibians, reptiles, and mammals depend on marshes for food for themselves and for their young, ranging from foraging tadpoles to unweaned muskrats.

### *Physical Environment Characteristics*

Complex interactions of tides and sediments at the shoreline provide a unique marsh environment that supports characteristic marsh plant and animal communities.

#### Hydrological Features

Water flow in marshes is affected by tidal patterns in the River and tributary streams. Marshes themselves, however, have their own unique hydrological features. From above, open water areas in a tidal marsh can be seen as branching patterns of channels similar to the outline of a tree. Channels are generally broadest where they intersect the River (or, in many cases, flow under railroad tracks) and divide into smaller and smaller branches toward land. Lower marsh plants line open water channels well into the upper marsh (Figure 14). The branching channels complicate the marsh's topography since, at low tide, raised hummocks of the upper marsh may be up to three feet higher than mucky substrates of the lower marsh associated with the channels. The network of channels provides a large area in which water and land overlap and drains the marsh during low tide, allowing semi-terrestrial plants to colonize the upper marsh (Frey and Bassan, 1978).

Although many gaps in knowledge exist concerning marsh hydrology, water in marshes is generally eutrophic (nutrient-laden) with high levels of suspended sediments and low levels of dissolved oxygen, especially during summer months (Odum et al., 1984). Aquatic animals found in the marsh are limited to species that can tolerate these conditions.

#### Geological Features

High productivity of marshes is largely due to the rich physical substrate upon which they occur. Marshes are often found adjacent to tributary mouths or in slow backwaters of the River where sedimentation rates are high. The sediment load that can be carried depends on water velocity and sediment particle size. When fast-moving water, heavily laden with sediments, enters near-shore and shallow areas, the water velocity decreases and the sediment load is deposited in layers of fine particles.

As a result of this continuous sediment deposition, marsh substrates (particularly in the lower marsh) consist of thick layers of rich, dark, "oozy" muck with high concentrations of silt, clay, and organic detritus. As a rule, sediments of lower marshes include less than 50% organic material, and those of upper marshes contain greater than 50% organic material (Odum et al., 1984). Cattail-dominated upper marshes can include large amounts of peat derived from annual accumulations of dead marsh vegetation.

Freshwater tidal marsh soils have high organic content, slightly acidic pH (6.0-6.5), moderate to strong reducing conditions, high cation exchange capacity, and are generally anaerobic except at the soil surface. These conditions lead to high concentrations of ammonium in contrast to the more familiar nitrates and nitrites of

**Figure 14:** *Lower marsh extending along channel at West Flats (N. Salafsky/TNC)*

terrestrial soils (Odum et al., 1984; Mitsch and Gosselink, 1987). Marsh plants can tolerate these harsh conditions or have adapted to avoid specific unsuitable conditions. For example, adventitious roots of many marsh species (e.g. beggar-ticks) may enable them to avoid anaerobic sediment layers while still competing for water-borne nutrients carried into the marsh (Whigham et al., 1980 *in* Odum et al., 1984).

Marshes at mouths of tributaries serve as catch basins for sediments (and pollutants) that flow down tributaries. Sediment loads and deposition rates are indicators of land use in surrounding upland areas. Evidence now suggests that sediment levels in tidal marshes have been rising very rapidly (in excess of 10.8 inches/century) over the past three centuries as a result of increased soil runoff associated with human activities (Froomer, 1980 *in* Odum et al., 1984). This linkage between marsh and the contiguous upland has important management implications; any attempt to preserve marsh must take into account actions occurring within the upland watershed.

*Tidal Marsh Identification*

Tidal marsh forms along the Hudson River where creeks and streams enter the River and in sheltered coves and backwaters. Marshes can be identified by the presence of non-woody plants one to ten feet high growing in areas where there is standing water for at least part of each day. Lower marshes are dominated by broad-leaved plants; vegetation of upper marshes consists primarily of tall grasses and grasslike plants. Substrates are usually muddy, although some areas are sandy. Marshes may be surveyed with some difficulty on foot at low tide or by canoeing through channels at high tide (consult tide tables for times).

## 1.6 Tidal Swamp

The tidal swamp community includes land adjacent to the River which is regularly flooded by tidal waters. Tidal swamp is the least common tidal community along the Hudson River and is equivalent to the *freshwater tidal swamp* community recognized by the New York Natural Heritage Program (Reschke, 1988).

*Plants of the Tidal Swamp*

Tidal swamps (or swamp forests) are dominated by a closed canopy of trees (Figure 15). Common species include green and black ash, red maple, and slippery elm. Beneath the trees is a layer of shrubs and vines including spicebush, arrowwood, silky dogwood, Virginia creeper, and poison ivy. At ground level, there is a layer of herbs, including rice cutgrass, sensitive fern, spotted jewelweed, common monkeyflower, knotweeds, skunk cabbage, hog peanut, groundnut, and swamp milkweed (Reschke, 1988). A gradual transition from tidal marsh to tidal swamp occurs in many places. Small trees and shrubs of tidal swamps grow in clusters in sections of marsh. Tidal swamps occur exclusively in freshwater, either near freshwater tributaries in brackish portions of the estuary or in upstream freshwater sections of the River.

**Figure 15:** *Swamp forest at Roger's Island (N. Salafsky)*

*Animals of the Tidal Swamp*

Although irregular flooding precludes regular use of tidal swamps by aquatic species, many terrestrial species use swamps (along with marshes) for feeding and breeding.

**Feeding**

Many insects and other invertebrates feed on plants, seeds, and other organic materials found in the tidal swamp. Vertebrate herbivores (leaf-eaters) and granivores (seed-eaters) include pheasants, rabbits, grey squirrels, chipmunks, woodchucks, mice, muskrats, beaver, and deer. Predators of these invertebrates and vertebrates include newts, salamanders, toads, frogs, a diverse group of turtles (including stinkpot, musk, painted, spotted, map, wood, and box turtles), snakes, shrews, moles, foxes, raccoons, weasels, mink, skunks, and (in theory) bobcats and bears (Conant, 1975; Burt and Grossenheider, 1976; Odum et al., 1984).

**Breeding**

Many of the above-listed animals also use drier portions of the swamp forest for nesting, although even there, use is limited by the saturated soils. Muskrats, which either build nests in the marsh itself or burrow in the nearby forest, are of particular importance. Kiviat (1978) found that many reptiles, including northern water snakes and snapping, musk, mud, spotted, wood, pond, and painted turtles, overwinter in abandoned muskrat burrows.

**Figure 16:** *Tidal Creek with upland forest in the background (N. Salafsky/TNC)*

*Physical Environment Characteristics*

Tidal swamps share many physical features with marsh and shore communities, but also have unique features. Tidal swamps have not been studied extensively and much remains to be discovered about physical conditions underlying formation of this community.

**Hydrological Features**

The irregular water flow in tidal swamps is one of their most interesting characteristics. Some areas (especially parts adjacent to tributary creeks) receive regular daily tidal flooding; others are flooded only during severe storms or spring flood-driven tidal surges (the latter communities are technically not tidal swamps, but *floodplain forests*). High water lines marked by natural and man-made debris left by receding waters are usually visible in floodplain forests. Because of their distance from the River, waters in regularly flooded swamps may have different nutrient and chemical compositions from the River. As a result, tidal swamps support specialized plants and animals adapted to a waterlogged environment.

**Geological Features**

Little is known about specific soils and sediments in tidal swamps, although they probably receive heavy sediment inputs from tides and floodwaters that inundate them. Forested wetland areas probably function as effective nutrient sinks (Mitsch and Gosselink, 1987).

*Tidal Swamp Identification*

Tidal swamps on the Hudson form landward of marshes and mudflats. This community can be identified by its characteristic tree species, which often grow on elevated hummocks between pools of standing water. Presence of flood debris is a good indication that the forest receives at least occasional inundation. Tidal swamp is best surveyed on foot, although dense underbrush can make walking quite difficult.

## 1.7 Freshwater Creek and Upland Forest

Although not tidally-influenced, freshwater creek and upland forest communities (Figure 16) play critical roles in determining where other communities occur in the River.

*Freshwater Creek*

The freshwater creek community consists of portions of tributary streams which are beyond the influence of tides, yet still accessible to fish from the River. On tributaries of the Hudson, this extends from the first significant elevation in creek beds to dams or waterfalls that block upstream passage of fish. Freshwater creeks are vital to many anadromous fish species whose eggs require fast-moving, well-oxygenated, and sediment-free water to hatch successfully.

### *Upland Forest*

The upland forest community includes the wooded hills and bluffs along banks of the River and its tributary streams. Upland forests are important for many terrestrial birds and animals that alternate between it and marsh and swamp. Upland forests are crucial in the hydrological cycle by serving as watershed buffering systems. These forests have absorbent soils and extensive root systems, which retain stormwater runoff, particularly when trees are in leaf and can absorb large volumes of water. This sponge-like retentive capacity allows surface waters to run off gradually over time. Gradually released runoff is less erosive than the rapid runoff associated with impermeable soils and developed areas. When upland forests in buffer zones adjacent to the River are removed, large-scale flooding and erosion can occur, which is detrimental to the value of tidal habitats.

**FURTHER READING**

The single most useful source on generalized atlantic coast freshwater tidal communities is **Odum et al., (1984)**, which focuses primarily on marshes but also provides a detailed overview of the entire tidal ecosystem, from physical factors to plant and animal communities. **Mitsch and Gosselink, (1986)** provides a short summary of physical and biological processes in freshwater tidal wetlands, as a part of their general text on wetlands. For field identifications of tidal wetland plants in the Northeast, as well as a brief summary of plant communities **Tiner, (1987)** is an excellent reference. For animals, standard field guides such as **Peterson, (1980)**, **Conant, (1975)**, and **Burt and Grossenheider, (1976)** are useful. The New York State Breeding Bird Atlas (**Andrle and Carroll, 1988**) provides information on all birds breeding in the state. Sources more specific to the Hudson include An Atlas of the Biological Resources of the Hudson Estuary (**Boyce Thompson Institute, 1977**) which provides an overview of plant and aquatic fauna in the River south of Poughkeepsie with particular emphasis on microscopic fauna and flora; and, **Kiviat, (1978 and 1979)**, which examine different ecological components of the River. Detailed descriptions of natural communities defined by the New York Natural Heritage Program can be found in **Reschke,. (1988)**. Finally, for an understanding of basic ecological and physical concepts introduced in this chapter, good general ecology and geology textbooks are available.

## Chapter 2:

# BIOLOGY OF RARE AND IMPORTANT SPECIES

---

*This chapter contains brief descriptions of the biology of rare and important animal and plant species found in the Hudson River tidal habitats. The species considered here do not constitute a complete list of animals and plants occurring along the River but are examples of species that are either endangered or are important for other reasons. Interesting aspects of each species are presented including background information, habitat requirements, and the status of the species in the Hudson River ecosystem. Species descriptions are presented according to the following categories:*

- *Mammals*
- *Birds*
- *Reptiles and Amphibians*
- *Fish*
- *Invertebrates*
- *Plants*

---

## 2.1 Rare Animal and Plant Species

Under federal law there are two categories of rare animals and plants: "endangered" and "threatened." New York State also maintains a list of animals that are endangered or threatened plus a third category for animal species of "special concern." The State has also compiled a list of endangered and threatened plants. These Federal and State categories reflect the level of concern regarding extinction of the species. Endangered species are faced with imminent extinction. Threatened species are in less danger, but require special protection in order to maintain their populations. Species which are of special concern have no legal protection but are listed because stability of the population is unknown. All species known to inhabit the tidal portion of the Hudson that are listed under these classifications are discussed in this section.

### Mammals

No endangered or threatened mammals are known to inhabit the Hudson River tidal habitats. Adjacent upland forest may provide habitat for the endangered eastern woodrat. The eastern woodrat has not been observed in the area in recent years. Although not inhabitants of the Hudson, many endangered marine whales and porpoises may depend on productive estuaries like the Hudson to contribute to the marine food web for their survival.

### Birds

Species of birds which are endangered, threatened, or of special concern along tidal portions of the estuary include raptors (birds of prey) and shorebirds.

#### *Bald Eagle*

The bald eagle is a Federal and State-listed endangered species found breeding during the summers along coasts, rivers, and large lakes in the northern U.S., Canada, and Alaska and wintering in the southern U.S. Bald eagles are considered non-breeding seasonal migrants to the lower part of New York State, using the Hudson River as a winter feeding ground.

**Background Information**

Mature bald eagles feed primarily on fish, various water birds, and carrion (Peterson, 1986). Depending on availability, fish constitutes the main food source for eagles and under most circumstances comprises between 50 and 90% of their diet. Bald eagles are primarily scavengers, obtaining much of their food from fish kills and other available dead animals.

While migrating, eagles follow mountain ranges to take advantage of associated thermal updrafts, and rivers which provide fish. Breeding pairs of eagles tend to return repeatedly to the same nest site. In New York, eggs are produced between mid-March and mid-May (Bull, 1985). The eggs are incubated for 35 days and the birds are fledged 72 to 74 days after hatching (DeGraaf and Rudis, 1986). During the breeding period, eagles are especially sensitive to human disturbance.

**Habitat Requirements**

Based on their dependence on fish as a food source, bald eagles breed and overwinter near large open bodies of water. For non-breeding and migrating eagles, important habitat requirements include open water in winter, high prey densities, and sheltered timber stands for protection from severe weather. For breeding pairs, lakes with surface areas of at least 3.7 square miles are the optimal size for successful nesting and (where available) are preferred over rivers. Although eagles rarely nest along the shoreline itself, nests are seldom found more than one mile from the waterline. Nests are situated mainly in large old-growth trees or on occasion, on cliffs or on the surface of large treeless islands. Nesting eagles are extremely sensitive to human disturbance and populations tend to be densest in areas with little or no human activity (Peterson, 1986).

Eagles are extremely sensitive to pollutants including lead shot ingested from wounded waterbirds, poisoned bait set out to kill raptors and other predators, and pesticides which severely weaken eagle eggshells and limit reproductive success (Grier, 1983). Pesticide effects are severe, since contaminants accumulate in fatty portions of many fish, the eagle's primary food source. This can lead to a high level of contaminants in eagles, even when concentrations in the environment are relatively low.

**Hudson River Population**

In New York State, both breeding and overwintering populations of bald eagles have undergone a drastic decline over the past century that has only recently been reversed with increased management efforts. Reports from the 19th century document dozens of eagles aloft at one moment along the southern part of the Hudson River during the spring migration, whereas in the 1970's, only one or two were seen during the entire migration period (Bird, 1985). Nesting sites along the Hudson in Orange and Westchester Counties have been abandoned since the 1890's (Bird, 1985).

In the last decade, however, with stringent protection and a decline in pesticide use, bald eagles have been returning to the Hudson. As many as twelve eagles have been counted overwintering near Iona Island, feeding near the River surface. Adult and immature eagles have been observed in both summer and winter at Moodna Creek and on adjacent Sloop Hill although nesting is not occurring (DEC, 1987; Mildner, pers. comm.).

The Hudson River could once again function as an important resource for migrating, overwintering, and breeding bald eagles. If bald eagles are to continue to return to the area, it is essential that key habitat requirements are met.

*Osprey*

The osprey is a State-recognized threatened species found along large bodies of open water. Osprey breed during the summer in the northern U.S. and Canada, and overwinter in the southern U.S., the Caribbean, and Latin America (R. Peterson, 1980). In New York, osprey migrate seasonally to most parts of the State and nest in the northern Adirondacks and on Long Island.

**Background Information**

Mature osprey feed exclusively on live fish. Osprey hunt by hovering above the water and then plunging, talons first, into the water to catch its prey. Osprey will take most fish species, but tend to concentrate on those that form large schools. Osprey breeding may be timed to take advantage of concentrations of anadromous fish during spawning runs (Greene et al., 1983).

Breeding osprey pairs return year after year to the same nest, which consists of a bulky stick structure situated high up in a tree or on poles or other artificial platforms (DeGraaf and Rudis, 1986). Osprey can be colonial breeders; sites on the east end of Long Island such as Gardiner's Island and Plum Island had over 250 active nests in the 1800's. In New York, eggs are produced between April 27 and June 21 (Bull, 1985). Eggs are incubated for 28 days and the birds are fledged after an additional 8 to 10 weeks (DeGraaf and Rudis, 1986).

**Habitat Requirements**

The primary habitat requirement for osprey is a plentiful and constant supply of fish. Consequently, osprey are found only near large lakes, rivers, and estuaries. Within these locations, areas of shallow water are preferred where fish swim close to the surface (DeGraaf and Rudis, 1986). Despite lengthy annual migrations, osprey do not disperse readily from their natal breeding sites and are slow to colonize new breeding areas. This tendency may explain why osprey do not readily return to inactive nesting areas (Henny, 1983). Osprey are fairly tolerant of human activities and can breed quite close to areas of human activity, even using telephone poles, duck blinds, and other structures as nesting platforms (Henny, 1983). Breeding ospreys, however, are extremely sensitive to organochlorine pesticide residues that interfere with eggshell formation (e.g. DDT), resulting in shells that are too thin to survive incubation. The presence of successfully breeding osprey indicates a pesticide-free local environment (Henny, 1983).

**Hudson River Population**

The osprey population along the Hudson declined over most of the twentieth century, but has been increasing over the past decade. Although pesticides have no doubt had a significant impact, habitat destruction seems to have also played an important role. Most of the known breeding sites along the Hudson including those at Hyde Park, West Point, Croton Point, and Yonkers have all been inactive since the late 1800's, well before the development of synthetic pesticides (Bull, 1985). Breeding osprey persisted, on the other hand, at less disturbed sites such as at Tivoli Bay until well into the 1950's when pesticides presumably became a factor (DEC, 1987). Currently, there are no known osprey breeding sites along the River but numerous sites including Schodack Island, North Tivoli Bay, Esopus Estuary, Moodna Creek, Wappinger Creek, and Fishkill Creek provide important osprey feeding grounds during the spring and fall migration periods (DEC, 1987; Mildner, pers. comm.). The lack of osprey breeding may indicate that existing levels of contaminants are interfering with establishment of this species on the River.

The Hudson River could become an important area for osprey breeding. If osprey are to return in their former numbers, key habitat requirements must be met. These requirements include a pesticide and pollutant-free environment with abundant fish populations, shallow open water feeding sites, and suitable breeding platforms that are protected from predators. Although two platforms erected in Tivoli Bay in 1985 have not been colonized, similar structures on Long Island and at other locations have been successful in attracting breeding pairs.

***Northern Harrier***

The northern harrier or marsh hawk is a State-recognized threatened species found in freshwater wetlands throughout northern North America in summer and in the southern U.S. and Latin America during winter. It breeds throughout New York but has been undergoing decline in recent years (Andrle and Carroll, 1988).

**Background Information**

Mature harriers feed primarily on small mammals and birds, reptiles, insects, and carrion (DeGraaf and Rudis, 1986). The harrier hunts almost exclusively over marsh areas and meadows, flying at low altitudes and diving on its prey.

Harriers are thought to mate for life; occasionally a male may be paired with two females. Unlike most other hawks, harriers build their nests on the ground where they are prone to high predation rates (Bull, 1985). In New York, eggs are produced between April 20 and June 25. The eggs are incubated for about 24 days and the birds are fledged 5 to 6 weeks after hatching (DeGraaf and Rudis, 1986).

**Habitat Requirements**

The primary habitat requirement for the harrier is large expanses of open marsh and meadow for both feeding and nesting. Although the harrier will hunt over pastures and agricultural lands, it is more prevalent in natural open areas (Bull, 1985). Nestlings are best able to hide from potential predators when they are well concealed among herbaceous or low woody vegetation (DeGraaf and Rudis, 1986) which is most commonly found in cattail marshes and other wetland areas (Bull, 1985). The effects of human disturbance on harrier populations is not discussed in the literature but it seems likely that the decline of the species in New York is related to an overall loss of marshes.

**Hudson River Population**

Although no specific census of the Hudson harrier populations has been conducted, it is likely that the species occurs in most suitable upper marsh areas along the River. It seems likely that population levels would benefit if these key nesting and feeding wetlands were protected from human disturbance.

### *Least Bittern*

The least bittern is a State-recognized species of special concern found in wetland areas of eastern North America during the summer and in the southern U.S., Caribbean, and Latin America during the winter (Hancock and Kushlan, 1984). It is found throughout New York in suitable habitats, although it is very secretive and often extremely difficult to spot.

**Background Information**

The least bittern's diet consists of small fishes supplemented with crustaceans, amphibians, small mammals, and insects (Hancock and Kushlan, 1984). Bittern hunt by wading slowly in shallow water with neck extended so that a rapid downward strike can be launched at a target, or at times by standing and waiting for prey to come by (Hancock and Kushlan, 1984).

Bittern are generally solitary nesters and undergo an extensive courtship ritual based largely on vocal cues. Nest sites are chosen by the male and located in the upper marsh near open water in extensive stands of reeds, cattails, sedges, or other dense vegetation. In New York, eggs are produced between May 15 and July 10. Eggs are incubated for 17 to 18 days and chicks remain as nestlings for 10 to 14 days during which time they are fed foods regurgitated by the parents (DeGraaf and Rudis, 1986). In some regions, secondary or replacement clutches have been observed, extending the likely nesting period.

**Habitat Requirements**

The primary habitat requirement for least bittern is large expanses of open marsh for both feeding and nesting. Least bittern are very secretive and do not tolerate human disturbance. Least bittern rely primarily on concealment for avoidance of predators. A suitable nesting site requires extensive stands of dense marsh plants with water that is between one and three feet deep at all times. Nests are built in the plants, one to two feet above the surface of the water (Swift, 1987). Important factors limiting least bittern populations are marsh drainage, pollution, and pesticides (DeGraaf and Rudis, 1986). In addition, the specific location of the nesting site near the boundary between upper and lower marsh makes the bittern vulnerable to changes in the marsh composition (Swift, 1987).

**Hudson River Population**

The tidal marshes along the Hudson River are currently an important breeding habitat for least bittern. In one study of six marsh areas, Swift (1986) conservatively estimated 2-3 breeding pairs at West Flats, 2 pairs at Stockport Marsh, 4-6 pairs in Hudson North Bay, 2 pairs at Tivoli North Bay, 3-4 pairs at Constitution Marsh, 1 pair at Iona Island, and comparable populations at other upper marsh sites.

Population levels of the least bittern along the Hudson River could potentially benefit by protecting upper nesting and feeding marshes from human disturbance. The availability of suitable nesting sites in dense marsh plants located near open water and protected from predators is of special importance. In addition, it may be beneficial to create or maintain lower marsh to keep pace with naturally occurring marsh succession (Swift, 1987).

## Reptiles and Amphibians

Only two reptile or amphibian species which are considered rare in New York occur in the tidal habitats, both of which are turtles.

### *Spotted and Wood Turtles*

Spotted and wood turtles are State-recognized species of special concern found primarily along the atlantic coast states and in isolated locations in the Midwest.

**Background Information**

Adult spotted turtles are primarily aquatic, feeding only in water on crustaceans, mollusks, spiders, earthworms, aquatic insects, frogs, tadpoles, small fish, turtles, and vegetable matter. Wood turtles are more terrestrial and feed either in water or on land on young vegetation, grass, moss, mushrooms, insects, worms, slugs, snails, tadpoles, and fish (DeGraaf and Rudis, 1986). In summer, both species are active during the day and can be found basking in the sun, especially during the morning hours. During winter, the turtles hibernate in muddy banks, marshes, stream bottoms, and abandoned muskrat burrows, spending most of the time in a deep torpor.

Spotted turtles mate between March and June and eggs are deposited from June to July. Eggs incubate for 70 to 83 days, hatching in late August or September. The newly hatched turtles may overwinter in their natal nests. Wood turtles breed between March and May when stream temperatures reach 59 °F. Eggs are deposited from May to June and hatch between August and November (DeGraaf and Rudis, 1986).

**Habitat Requirements**
Spotted turtles live in shallow, unpolluted bodies of water including ponds, marshes, swamps, and tidal creeks. They prefer areas with aquatic vegetation and tend to hide in the mud. Spotted turtles lay their eggs in well drained upper marsh areas or in tussocks. Wood turtles are found in slow-moving meandering streams from which they disperse to surrounding woods and fields in summer. In winter they return to stream areas to hibernate in muddy banks. Wood turtles lay their eggs in depressions prepared in sandy or gravelly soils (DeGraaf and Rudis, 1986).

**Hudson River Populations**
Little is known about turtle populations along the Hudson River. Although considerable research still needs to be done on turtle biology, existing turtle populations may benefit by preserving suitable unpolluted marshes. Turtle populations would be enhanced by protecting summer nesting grounds from disturbance by hikers, recreational vehicles, and even reptile collectors. It is also important to protect winter hibernation areas from disturbance from dredging, filling and grading.

## Fish
The shortnose sturgeon is the only Federally and State-recognized endangered Hudson River fish species.

*Shortnose Sturgeon*
Shortnose sturgeon are distributed along the atlantic coast from the St. John River in New Brunswick to the St. Johns River in Florida. It is estimated that from 13,000 to 30,000 mature individuals live in the Hudson River, comprising the largest known population of the species. The shortnose sturgeon lives and breeds almost exclusively in riverine and associated estuarine environments; its survival depends on maintenance of habitat in rivers such as the Hudson.

**Background Information**
Fertilized shortnose sturgeon eggs are found upriver from saline waters between mid-April and mid-May. Eggs are adhesive and attach to hard substrate in deeper portions of the River where they hatch after an average of 13 days at a temperature of 50 °F (Dovel, 1981; Smith, 1985). Newly hatched larvae and juveniles are benthic (found at the river bottom) and remain in the freshwater portions of the River, feeding first on zooplankton and later on crustaceans, insect larvae, and cladocerans. Adults apparently move down river into brackish waters after spawning. Adult shortnose sturgeon are largely bottom feeders, consuming mollusks and other benthic animals with their protrusile tube mouths (Crance, 1986).

Shortnose sturgeon males are capable of reproduction at age 2 to 3 and thereafter reproduce every other year, whereas females first spawn between ages 6 and 11 with a 3 to 11 year hiatus between reproductive efforts (Crance, 1986). In a given reproductive year females produce between 40,000 and 200,000 eggs.

**Habitat Requirements**
The shortnose sturgeon, unlike its larger cousin the Atlantic sturgeon, spends most of its life in the riverine or estuarine environment. The extent to which the fish enters marine waters is unknown. In the northern part of its range (including the Hudson), shortnose sturgeon moves up and down rivers with the seasons, feeding in shallow brackish or freshwater sections during the summer and overwintering in the lower portion of the estuary or in deep freshwater areas (Crance, 1986). In the southern portion of the range, however, there is some evidence that the fish is more anadromous, entering the river only to spawn and spending the rest of its time in coastal waters (Smith, 1985). In general, shortnose sturgeon may forage in relatively slow moving water over gravel and silt or shallow muddy bottoms at a depth of about 10 feet, although in winter they occupy deeper areas that range from 10 to more than 30 feet (Crance, 1986).

Shortnose sturgeon reproductive activity occurs in freshwater portions of rivers and is generally associated with moderately deep areas (6-36 feet) that have a gravel to rubble substrate, water velocities between 1.2 and 4.1 ft/s, and a temperature between 54 and 59 °F (Crance, 1986). There is evidence that spawning may occur only within a narrow 3-6 day "window" in which the environmental conditions are suitable for successful egg deposition (Crance, 1986).

**Hudson River Population**
Shortnose sturgeon follow a complex migration in the Hudson (Dovel, 1981). Before the spring spawning season, most breeding shortnose sturgeon congregate in the shallow areas of Esopus Meadows below Kingston, while other non-reproductive individuals remain in the deepwater areas of Haverstraw Bay. By about March, along with ice breakup, adult fish begin moving upriver at a rate of 2 to 3 miles per day reaching the spawning areas between Coxsackie and Troy during late April and early May. After spawning, adults return to the lower portions of the estuary while newly hatched larvae and juvenile fish slowly migrate downriver throughout the summer. While adult fish tend to feed in the shallow areas of the River, juveniles are found at the bottom of the channel in regions of strong currents with water depths greater than 30 feet (Dovel, 1981; MPI, 1983).

The Hudson River shortnose sturgeon population has been identified as suffering from several stresses that could potentially be linked to pollutants in the water of the River. Seventy-six percent of 585 shortnose sturgeon observed during the 1980 spawning season showed signs of fin rot which has been linked in other fish species to the chemical deterioration of the epithelial mucus coating. In the Hudson, PCBs may be linked to this condition. As a bottom feeder, shortnose sturgeon tend to accumulate toxins rapidly. Extremely high levels of PCBs have been found in shortnose sturgeon tissue ranging from 22 ppm in muscle to 997 ppm in brain tissue. Presumably the shortnose sturgeon population suffered from the polluted conditions in the "Albany Pool" spawning grounds between 1960 and 1980 and may only now be recovering. Thermal pollution may also affect this species. Temperatures over 77 °F can cause distress or even mortality among young individuals, suggesting that thermal discharges should be evaluated for impacts on the shortnose sturgeon population (Dovel, 1981).

Protection of the Hudson River population is important for the survival of this endangered species, since the Hudson River contains one of the largest populations of shortnose sturgeon. The loss of suitable spring spawning and nursery grounds upriver, shallow adult summer foraging grounds midriver, and deepwater overwintering areas downriver are of particular concern. Protection of the Hudson River shortnose sturgeon population requires scheduling of human activities to minimize impacts during reproductive periods. Activities of concern include dredging, water intake by power plants and other large users, commercial fishing for Atlantic sturgeon and other fish which may result in incidental catch of shortnose sturgeon, and discharge of pollutants.

## Invertebrates

No legally-recognized endangered invertebrate species currently live in the Hudson River. Further study is needed to determine which species might be experiencing unstable or declining population levels which may warrant protection under existing law.

## Plants

The Hudson's tidal habitats support a number of rare plant species. Many of these species are recognized by the State as "protected native plants" which are listed as either endangered, threatened, exploitatively vulnerable or rare (Article 9, Section 15 of the Environmental Conservation Law). A list of recognized plant species was adopted on June 23, 1989, and includes two species which are good examples of plants that depend on the Hudson's tidal habitats. These and other listed plant species are protected from removal or damage by requiring the consent of the landowner. Effective protection can result from this law since many species live in the intertidal area which is mostly under State ownership. Removal or damage of plants carries a $25.00 fine per plant or stem.

### *Heart Leaf Plantain*

Heart leaf plantain is a State-recognized threatened perennial plant that exists only in tidal waters in New York, although it also occurs in freshwater streams in several states in the Midwest and the Southeast.

#### Background Information

The heart leaf plantain, whose biology is detailed in Bender (1986), grows either individually or in loose clusters. Heart leaf plantains produce different-shaped leaves depending on the season; in winter the distinctive large heart-shaped leaves of the summer are replaced with small lanceolate leaves. In spring and fall, the plant can have intermediately sized and shaped leaves. Leaf production can be affected by drought or temperature stress and is controlled by length of day.

Heart leaf plantains initiate flower production in the fall and the new buds overwinter under protective leaf bases. In the spring, a large spike grows rapidly, holding up to 130 individual flowers. The flowers are wind-pollinated and, once fertilized, the plants form mature fruits one to three weeks later. Each fruit capsule contains two seeds which dehisce (open up) when the fruit is ripe. When a seed falls into the water, the seed coat swells into a mucilaginous mass that gives the seed buoyancy and causes it to stick to any object that it touches. Seeds germinate in 6 to 14 days with the majority of seedlings ending up in close proximity to their parent. Established seedlings can take up to 2 years to mature.

Heart leaf plantains have the lowest reproductive output of all plantain species, which may in part be due to the fact that much of their energy is used to produce big leaves and fleshy roots. This low reproductive effort means that they produce very few seedlings and are vulnerable to disturbances that disrupt seedling germination and establishment.

#### Habitat Requirements

Heart leaf plantain is a semi-aquatic plant that grows in gravelly or rocky beds of shallow, clear streams and their adjacent floodplains in the Midwest and the Southeast. It is also found in a mud-bottomed woodland stream in Ohio and in moist depressions in a deciduous woods in Ontario. Along the Hudson, the heart leaf plantain occurs largely on rocky shores just below the high tide mark. The plant is generally found at the mouth of a tributary stream or in a cove or backwater area along the River. Heart leaf plantain is often partially obscured from full view by other upland woods plants that hang over the narrow strip in which the plantain grows. In general, the heart leaf plantain is not very tolerant of excessive pollution and in New York, may depend on the flushing action of the tides for survival.

#### Hudson River Population

Heart leaf plantain is currently found at twelve sites along the Hudson. While some of these sites contain several thousand mature plants, others have only a few dozen. The Hudson River population is thought to be in decline, since many sites in which the species was found in the 1930's no longer support the plant. This decline is attributed to both habitat alteration and to declining water quality. Major threats to the heart leaf plantain include clear cutting of surrounding woods, trampling, alteration of stream flow, exposure to erosive forces, and industrial and domestic pollution. Particular problems are associated with increased stream flow washing seedlings away, nutrient overloading causing extensive algal growth that traps and kills seeds, and trampling of plants by people, animals, and vehicles on the shore.

*Estuary Beggar-ticks*

The estuary beggar-ticks is a State-recognized threatened annual plant found in estuaries between Maryland and New York. The species is one of many congeners (closely related plants) found in tidal habitats (Gleason, 1952).

**Background Information**

The estuary beggar-ticks grows individually or in small groups. Seeds from the previous year germinate in spring and sprout leaves. Flowering occurs in late August and September with the plants being pollinated by insects. Seeds ripen in late September and October and have tiny hooks that latch onto passing animals and humans for dispersal. Most seeds, however, probably fall near the parent plant.

**Habitat Requirements**

Along the Hudson River, estuary beggar-ticks is found in two different habitat types. The most common occurrence is in the sandy beach habitat, near the high tide mark. In this habitat the plant is occasionally found among three-square bullrush plants on the actual "beach," but it is more commonly found on a small eroding ledge that is located between 4 and 12 inches above the beach. Estuary beggar-ticks grows only on the very lip of this edge and no further inland; it seems to be able to establish itself only in a very transitory environment. The plant in this habitat is generally very short and squat. The estuary beggar-ticks is also found in a much taller form that grows on rocky shores. Here the plant is found more in the open and in generally lower densities.

**Hudson River Population**

The estuary beggar-ticks is found at ten known sites along the River. While a few of these sites contain several hundred plants, others have only a very small population. Major threats to the estuary beggar-ticks are linked to habitat loss and elimination of local populations. Maintenance of existing populations requires protection from shoreline development and disturbance. Research should be undertaken to determine the extent to which the plant is aided by erosion or if this process is detrimental to its existence.

*Other Rare Plants*

Other plants found in the Hudson River tidal environments that are being monitored by the New York Natural Heritage Program include the saltmarsh bulrush, sedge *(Carex hormathodes)*, winged monkeyflower, lousewort, spongy arrowhead, bur-marigold, beggar-ticks *(Bidens hyperborea)*, mud-plantain, and pigmyweed (see Appendix A for additional scientific names). Threats to the Hudson River populations of these plants are linked to loss of habitat or to the direct destruction of localized populations. Additional information on rare plants can be obtained through the New York Natural Heritage Program.

## 2.2 Important Species

Important animal and plant species are those which satisfy food, recreation, and other human needs.

### Mammals

A wide variety of mammals use the tidal habitats for some portion of their life cycle. Many of the mammals that are most dependent on the River are important as furbearers.

*Muskrat*

The muskrat is a small rodent found throughout the United States and Canada.

**Background Information**

Muskrats are omnivorous, feeding primarily on cattails, reeds, pondweeds, bulrushes, water lilies, clams, and other small aquatic animals (DeGraaf and Rudis, 1986). Muskrats will on occasion build small, roofed feeding platforms and dome-shaped nest chambers of weeds over the water. Other individuals nest in dens dug in banks of streams or ditches. Muskrats breed between March and August and have a gestation period of about 30 days. Since the average litter size is five or six, a female may have up to three litters per year; and since the age to maturity is as short as 4 months, muskrats have an enormous population growth potential which can take advantage of productive habitat.

**Habitat Requirements**

Muskrats live in marshes, shallow lakes, ponds, swamps, sluggish streams, and even drainage ditches. They require wetland areas with dense emergent vegetation and more or less stable water levels. They are most common when abundant supplies of cattails, the muskrat's preferred food, are present.

**Hudson River Population**

Muskrats are found throughout suitable habitats along the Hudson River. As in other environments, the size of the Hudson's muskrat population fluctuates widely, which may be based on the availability of suitable overwintering burrows and water level. Muskrat populations along the River may benefit by preserving and enhancing marsh. Preventing exotic plants such as purple loosestrife and common reed from displacing cattails and other preferred foods may also be important for muskrat populations.

### *Mink*
The mink is a small carnivore found throughout the U.S. and Canada.

**Background Information**
Mink feed primarily on small aquatic and terrestrial animals. Primary foods include muskrats, voles, rabbits, fish, frogs, crayfish, salamanders, clams, and insects (DeGraaf and Rudis, 1986). The animals are largely nocturnal and are active throughout the year.

Mink build their dens below ground under fallen trees or stumps or in hollow logs. Mink breed in the early spring and have a gestation period of about 50 days but delay implantation of the embryos in order to give birth in April or May. A litter contains an average of 3 or 4 kits.

**Habitat Requirements**
Mink are found in streambanks, lakeshores, and marshes. They tend to prefer areas where there is extensive cover and they defend large territories. In general, mink prefer wetlands with irregular and diverse shorelines. Mink are reasonably tolerant of human disturbance but are sensitive to prey levels which may drop in conjunction with human development (Allen, 1986). Mink may also be limited by the availability of suitable den sites.

**Hudson River Population**
In general, mink population sizes depend on the availability of wetlands that are surrounded by dense woods and shrubs to provide adequate cover. Mink populations may also be affected by pollutants in the estuary, particularly PCB's. The Hudson River populations may benefit by protecting marshes and adjacent swamp and woodland in order to maintain the small animal populations that serve as food sources.

## Birds
Hundreds of bird species are found along the Hudson, all of which have great value to bird-watchers and other nature lovers. Species discussed here are limited to examples of waterfowl and wetland-dependent wading birds associated with the Hudson.

### *Ducks*
The term "ducks" encompasses a large group of migratory waterfowl that live throughout the world. Ducks inhabiting the Hudson can be divided into four categories: marsh or dabbling ducks (black, mallard, gadwall, wood, pintail, green-winged teal, blue-winged teal, and northern shoveler); diving ducks (redhead, ring-necked, canvasback, greater and lesser scaups, goldeneye, bufflehead, and ruddy); sea ducks (oldsquaw and surf, white-winged, and black scoter); and mergansers (hooded, common, and red-breasted)(R. Peterson, 1980). Many of these duck species can be found in many areas of New York during spring and fall migrations and are the most frequent quarry of waterfowl hunters.

**Background Information**
Marsh ducks feed on aquatic plants, seeds, grass, insects, and small aquatic life. A marsh duck feeds in water by "dabbling", ie., in a position where its body is tilted with its head underwater and tail pointed up in the air. Certain species such as wood ducks also forage on land for seeds, nuts, waste grains, and insects. Diving and sea ducks feed underwater on small aquatic animals and plants. Mergansers are diving ducks with saw-toothed bills that are adapted for capturing small fish.

Many ducks embark on lengthy migrations in the spring and fall between summer breeding areas and winter feeding grounds. Most duck species found on the Hudson are present only during migration to the breeding grounds in northern or central Canada and are seldom found during the summer months. Species that do breed on the Hudson include black duck, mallard, wood duck, blue-winged teal, and hooded merganser. Additional information on these and other species breeding in New York can be found in the New York State Breeding Bird Atlas (Andrle and Carroll, 1988).

**Habitat Requirements**
The primary habitat requirement for overwintering ducks is access to open bodies of water where they can feed and rest secure from predators. An adequate supply of food is important and is generally available in marshes and shallow water.

Breeding black and mallard ducks build their nests in the marshy borders of ponds, lakes, rivers, and swamps and adjacent uplands. Black ducks will settle in salt and brackish water areas, while mallards avoid salt water. Both require shallow water where they can reach bottom or submerged plants while dabbling from the surface. Wood ducks and hooded mergansers nest in cavities in large trees (or nest boxes) adjacent to freshwater wetland feeding areas (DeGraaf and Rudis, 1986).

**Hudson River Populations**
Ducks use the Hudson River Valley as a major migration corridor as they travel between northern breeding grounds and southern overwintering areas. During migration, ducks stop along the River in large numbers to feed and rest. In addition, thousands of ducks overwinter along the southern portion of the estuary where the water remains ice-free for the winter. Both hunters and bird-watchers come to the Hudson River from throughout the surrounding area during fall migration. Duck populations receive a great deal of management attention and protection through international, Federal, and State efforts. The Hudson's duck populations may benefit by maintaining open water in specific wetland areas, limiting pollutants, preserving wetland quality and associated food value, and by providing refuges free from human disturbance during migration.

### *Canada Goose and Brant*

The Canada goose and its close relative the brant are large migratory waterfowl that traditionally bred in the arctic and overwintered in the coastal and midwestern portions of the United States. The Canada goose is found throughout New York during the spring and fall migrations and on Long Island and the Hudson during the winter (Bull, 1984). Canada geese are now also found breeding throughout southern New York (Andrle and Carroll, 1988).

#### Background Information

Canada geese and brant are herbivores and granivores (plant and seed eaters) feeding primarily on tender grass shoots, sedges and other marsh plants, submerged vegetation, wild seeds and fruit, and cultivated grains. Canada geese are well-adapted to using human crop foods and geese populations may have increased with increased food supplies associated with conversion of woodlands to farmland (Bellrose, 1976). Canada geese feed primarily on land and in marsh areas, whereas brant prefer feeding in shallows and flats on aquatic vegetation. Brant drastically altered its feeding habits in the mid-1930's when eelgrass, a primary food source, succumbed to a blight and almost completely disappeared. With the loss of eelgrass beds, brant changed to a secondary source, sea lettuce. In recent years, eelgrass has become more common and is once again available to brant. Geese migrate to and from their wintering grounds in large flocks that form at certain "staging areas." In flight, the geese are often seen in characteristic V formations which are brought to our attention by their almost continuous honking.

#### Habitat Requirements

Primary habitat requirements for overwintering geese and brant are access to large open water areas where the geese can rest secure from predators, and snow-free feeding sites.

#### Hudson River Populations

Canada geese use the Hudson Valley as a migration corridor, concentrating on the east shore of the River and uplands as they travel to wintering grounds along the atlantic coast and breeding grounds in New York and Canada. In addition, geese from the maritime provinces of Canada migrate along the atlantic coast to overwinter near Long Island and perhaps the lower Hudson Valley (Bellrose, 1976). In recent years, as many as 20,000 geese have remained in the upper Hudson Valley in mid-winter, along with large numbers concentrated in urban or suburban flocks around New York City. Part of the increase in overwintering geese in New York appears to be due to a northward shift in the winter range of geese, which traditionally had been concentrated in the Chesapeake area. The Hudson Valley is also a major brant migration corridor between a staging area in James Bay in the Province of Ontario and wintering grounds along the atlantic coast.

Populations of Canada geese and brant receive substantial management attention and protection at the international, Federal, and State levels. These species will continue to depend on the Hudson Valley in their migrations and for overwintering and should be protected from potential disasters including oil spills from barge traffic and storage facilities, and pesticide poisonings which are frequently associated with golf course and lawn maintenance.

### *Herons*

Herons are large wading birds found throughout the world near water. Species found along the Hudson estuary include great blue, black-crowned night, and green-backed herons, great egrets, and American and least bittern. These heron species are distributed throughout the United States and southern Canada during the summer and migrate in winter to the southern U.S., the Caribbean, and Latin America. Some individual great blue herons do remain in the north for the entire winter near open water. In New York, all of the listed herons are breeding species, with some breeding only on Long Island and others throughout the State (Bull, 1985). Although the herons (in particular the great egret and great blue) were hunted extensively in the early 1900's for their feathers which were used in the millinery trade (Bull, 1985), they are now valued for their grace and aesthetic contribution to the landscape.

#### Background Information

Herons feed primarily on small fishes and to a lesser extent on amphibian, snake, lizard, rodent, small bird, insect, and aquatic invertebrate species (Hancock and Kushlan, 1984; Short and Cooper, 1985). Colonial heron populations have been known to feed in large flocks but the birds generally forage alone or in small groups (Short and Cooper, 1985).

Migratory herons return from the south in spring to begin the breeding season. With the exception of green-backed herons and bittern, herons tend to be colonial. Dozens of pairs crowd into established "heronries" that can include several different heron species. Herons can also be solitary breeders, however, with great blue herons nesting in tall trees, green and black-crowned herons in smaller trees or on hummocks in cattail marshes, egrets in dense scrub thickets, and bittern in wetter portions of the upper marsh. General biology of herons breeding in New York can be found in the New York State Breeding Bird Atlas (Andrle and Carroll, 1988).

#### Habitat Requirements

Primary habitat requirements for herons are large expanses of open shallow water for feeding, and appropriate nesting sites. The two bittern species are both very secretive, feeding and breeding in the wetter portions of the upper marsh and relying primarily on concealment for escaping nest predators. Both of these species are very intolerant of disturbance and will abandon an area if it is even slightly disturbed (DeGraaf and Rudis, 1986).

Other herons feed primarily on mudflats and shallows near marshes. Great blue herons often build nests in large swamp forest trees which may be located far from their main feeding grounds. While great blue herons can tolerate human disturbance, a Minnesota study found that all major heronries are located at least two miles from human residences and are generally occupied year after year until disrupted by logging or other human activities (Short and Cooper, 1985). Green-backed and black-crowned herons are more tolerant of human activities and have less demanding nesting site requirements than great blue herons. In addition to loss of foraging and nesting sites, there is evidence that heron populations have been reduced by heavy metal and organochlorine pesticide contaminants that can contribute to eggshell thinning and hence increased hatching mortality (Short and Cooper, 1985).

#### Hudson River Populations

The Hudson River supports breeding populations of least bittern and green-backed herons. Great blue herons use the River for feeding although no active heronries are known to exist on the River. Great egret, American bittern, and black-crowned night heron also forage at many sites along the River during the summer, but no nesting has been reported. Herons that may depend on the River as a source of food may establish heronries some distance away from the River in wooded uplands. Great blue herons are the only species that overwinter and can occasionally be found in the southern portions of the estuary (Andrle and Carroll, 1988).

Although herons have little economic value, in the words of Peterson (in Hancock and Kushlan, 1984) they enjoy an immensely high public relations rating among wildlife observers and conservationists. The Audubon movement was sparked by the near extinction of great egrets caused by the demand for feathers in the early 1900's for the millinery industry. Since that time, herons have been used as a symbol of the conservation and environmental movements.

Heron populations along the Hudson River can be maintained and enhanced through the preservation of marshes. The availability of densely vegetated nesting sites in deepwater marsh areas for bittern, and large trees in undisturbed areas for great blue herons are of special importance.

## Reptiles and Amphibians

No commercially valuable reptile or amphibian species inhabit the Hudson other than the snapping turtle which is occasionally hunted (although it can contain high levels of toxic chemicals). In addition, rare turtles native to the Hudson are unfortunately hunted by collectors.

## Fish

Several fish species are commercially valuable and several others support recreational fisheries along the River.

### *American Shad*

American shad, an anadromous which is native to North America, is found along the atlantic coast from Labrador to Florida. The species was introduced to the Pacific in 1871 and is now also found from Mexico to Alaska (Stier and Crance, 1985). Historically, American shad has been one of the most important commercial fish on the Hudson and is now the mainstay of the River's fishing industry.

#### Background Information

Fertilized American shad eggs are slightly heavier than water and are initially mildly adhesive, causing them to be transported slowly with the currents in the channel during their two day incubation period (Smith, 1985). After hatching, larvae spend 4 to 5 weeks drifting from the spawning grounds. Juvenile shad form schools and move gradually downstream, feeding opportunistically on aquatic insects and zooplankton in the water column. It is not known whether juveniles spend their entire first year in the estuary or if they migrate to the ocean. Adults spend late summer and early fall between the Gulf of Maine and Nantucket, and winter off Long Island. Adult shad are primarily plankton feeders, swimming with mouths open to strain the water for copepods, mysids, crustaceans, and some small fishes (Stier and Crance, 1985).

Adult shad remain in the ocean for 2 to 6 years before spawning. Shad spawn once and die in the southern part of the species' range whereas fish from northern populations are able to spawn more than once (Stier and Crance, 1985). In northern populations such as the Hudson's, spawning occurs in spring and early summer with individual fish returning to their natal tributaries to spawn at night in clear, fresh water. Female shad can produce between 58,500 and 659,000 eggs in a given reproductive season, indicating low juvenile survival rates (Stier and Crance, 1985).

#### Habitat Requirements

Eggs, larvae, and juvenile American shad require fresh, well-oxygenated water (greater than 5.0 ppm of oxygen) that is at least 60 °F, although they can tolerate water as cold as 40 °F. Suspended sediments greater than 100 ppm have a lethal effect on shad larvae (Stier and Crance, 1985). Adult shad occur in offshore areas of the ocean at intermediate depths where water temperatures range from 38° to 60 °F.

Shad spawning runs depend on water temperature; peak migrations coincide with a temperature of 65 °F in estuaries and rivers. Spawning can occur in all parts of the River, but is concentrated in shallow, well-oxygenated, and swiftly moving (0.3-4.3 ft/s) water over a sand and gravel substrate (Stier and Crance, 1985). Shad tend to spawn in the shallows at the mouth of tributary streams and in broad, shallow portions of the River that meet the above requirements.

**Hudson River Population**
In the Hudson, spawning occurs from Croton Bay north to Castleton with greatest densities near Catskill (Smith, 1985). Prior to completion of the federal dam at Troy, American shad were reported as far upriver as the Batten Kill. Currently, American shad is one of the major fish species taken commercially in the Hudson River. Commercial fishing operations take advantage of the shad spawning runs by using staked, anchored, or drifted gill nets. Commercial fishing is prohibited from Friday night to Sunday morning, which protects the spawning stock by allowing fish to pass upstream to spawn (Smith, 1985). Historically the annual shad catch has ranged from 38,300 to 2,091,300 pounds with an average annual catch of 638,200 between 1913 and 1964, 107,700 pounds between 1965 and 1974, and over 1 million pounds in recent years (MPI, 1983; Paul Neth, pers. comm.).

The American shad population in the Hudson River can be maintained by protecting important shallow, mid-river spawning grounds, and feeding and nursery grounds of larval and juvenile fish. The shad population will be least affected if human activities are scheduled to avoid interference with critical life periods of the fish. The need to avoid dredging during periods when the resulting increase in suspended sediment load might interfere with shad larvae is particularly important. Likewise, any action that might alter water temperature, reduce dissolved oxygen levels or increase sedimentation should be scheduled to avoid interference with adult migration to and use of spawning grounds and use of feeding and nursery grounds by young fish. The American shad commercial fishery management activities of the New York State Department of Environmental Conservation should continue to be supported in order to maintain the spawning stock for this species.

***Atlantic Sturgeon***
The Atlantic sturgeon is a large anadromous fish found along the east coast of North America between Labrador and northern Florida. It has long been an important commercial fish in the Hudson River.

**Background Information**
Newly hatched Atlantic sturgeon remain in the estuarine environment between 1 and 6 years, feeding first on plankton and detritus and later on larger food items on the River bottom (Dovel, 1978; Smith, 1985). During their time in the estuary, Atlantic sturgeon movements are correlated with water temperature, heading upstream in spring and downstream in late summer. Eventually, the fish migrate to the ocean where they move south along the coast in fall and north in early spring. Adult Atlantic sturgeon are bottom feeders and subsist on worms, amphipods, insects, and small fish found in or on the bottom sediments.

Atlantic sturgeon spawn just upriver from the salt front. Males are at least 12 years old when they first spawn while females mature at age 18 or 19. In a single reproductive cycle, a female can produce several million eggs (providing the basis for the caviar industry).

**Habitat Requirements**
Atlantic sturgeon are found in deep water while in the estuary. They generally move with the tides, remaining in waters that are about 55 °F. Temperature also controls the movements of juveniles which begin migrating downstream in fall.

**Hudson River Population**
Juvenile Atlantic sturgeon overwinter in the deepwater portions of the Hudson River estuary between Cornwall and the George Washington Bridge. In spring the juveniles can be found as far north as Port Ewen. Adults generally are not found in the River during the winter but migrate from the sea in spring to reproduce. Spawning occurs just north of the salt front which is usually located in Haverstraw Bay in spring. After spawning, females leave the River for the ocean, but males may remain until cold weather returns.

Atlantic sturgeon was the backbone of the nineteenth century Hudson River fishery. The fish were so plentiful that they were called "Albany beef." Atlantic sturgeon was heavily overfished, however, and the population was decimated. In 1978 it was estimated that there were 100,000 juvenile Atlantic sturgeon in the estuary but only several dozen adults were being taken annually by commercial fishermen.

As with other fish species, Atlantic sturgeon population levels can be maintained by limiting harvest to sustainable yields. This is particularly difficult to manage for long-lived species such as the Atlantic sturgeon where it takes almost 20 years for females to reach maturity. Given the historic abundance of Atlantic sturgeon on the Hudson, the opportunity may exist to encourage an increase in the population by protecting the spawning stock from exploitation until a higher sustainable yield can be achieved in the future. Successful spawning may also be related to the location of the saltfront in relationship to Haverstraw Bay in the spring; currently proposed water withdrawals have the potential to move the salt front's location which may affect the survival of this species.

***Striped Bass***
Striped bass is an anadromous fish species found in the Atlantic between the Gulf of St. Lawrence and northern Florida. This species also occurs in the Gulf of Mexico and has been introduced to the Pacific. Striped bass is one of the most important commercial and sport fish in

the U.S. In addition to the Roanoke River and Chesapeake Bay, the Hudson is a major spawning area for Atlantic striped bass.

**Background Information**

Striped bass eggs are semi-buoyant and remain suspended in the water column when a current is present (Bain and Bain, 1983; Crance, 1984; Smith, 1985). Juveniles spend the summer and fall in the estuarine environment, feeding on rotifers and copepods (Chesapeake Bay Program, 1987). With the arrival of colder weather, some juveniles remain in marshes and shallows while others apparently move to brackish, deeper portions of the estuary. Juvenile striped bass spend two or three years in the estuary and adjacent marine areas before migrating to the open ocean (Striped Bass Task Force, 1984). Adult fish feed on silversides, menhaden, shrimp, herrings, killifish, squid, and invertebrates.

Striped bass remain in the ocean for 4 to 7 years before returning to the estuary to spawn. Spawning is fairly violent and involves rolling and splashing at the surface in what are termed "rock fights" (Smith, 1985). Spawning generally occurs in fresh water near the salt front and is triggered by the presence of suitable temperature and current.

**Habitat Requirements**

Spawning occurs in deep waters that have strong currents, extensive freshwater flows, and a rocky substrate that is not subjected to sedimentation. Spawning starts when the temperature reaches 58 °F, reaches its maximum when the temperature is between 61 and 66 °F, and ceases at 72 °F (Striped Bass Task Force, 1984). Other favorable factors are sufficient oxygen levels and a large freshwater input to the estuary (Bain and Bain, 1983). Striped bass has been the subject of numerous toxicity tests. Eggs and larvae can be significantly affected by small concentrations of heavy metals and other toxic chemical compounds including PCB's.

**Hudson River Population**

Striped bass move into the River in April and remain until mid-June (Smith, 1985). Spawning occurs between Iona Island and Kingston, mainly between Storm King and Bear Mountain where there is an extensive section of suitable deep water. Juveniles remain throughout lower portions of the estuary for the summer and move further downriver to overwinter. Between thirty and sixty percent of the Hudson River juvenile striped bass population may overwinter near Manhattan's west side inter-pier area. Based in part on the decline in Chesapeake Bay striped bass stocks, over fifty percent of the north atlantic striped bass stock may originate from the Hudson (DEC, 1986).

In New York and New England marine waters, "stripers" were the prime catch for both commercial and sport fishermen and also the subject of much controversy. The commercial striped bass fishery was closed in the Hudson in 1976 because of PCB contamination. In 1981, based on severe decline in the striped bass population, the Atlantic States Marine Fisheries Commission recommended that member states' striped bass fishing regulations be made more restrictive. In 1983, New York passed a law increasing the size limit on bass that could be taken commercially in the marine district. New York's law, however, was more restrictive than the Commission's recommendations, placing New York's fishermen at a competitive disadvantage with fishermen from other states (Striped Bass Task Force, 1984).

In 1985, the size limit issue became moot when commercial striped bass fishing was banned from all New York marine waters due to PCB contamination except for eastern Long Island (Dullea, 1985). This exception, along with continued recreational fishing, made enforcement of the ban on selling fish from the Hudson River difficult. The inability to enforce this ban led to new legislation in 1986 making the sale and possession of striped bass illegal in New York State (Dieffenbacher-Krall, 1986). The complete ban on striped bass fishing caused great outcry among sport fishermen, however, and the law was amended in 1987 to permit recreational fishing for striped bass 33 inches or greater in marine waters and 18 inches or greater in the Hudson River. The New York State Department of Health also issued an advisory against the consumption of striped bass caught in New York waters.

### *Alewife and Blueback Herring*

Alewife and blueback herring, collectively termed "river herring," are small anadromous fish distributed along the atlantic coast. Although they are commercially harvested, their chief importance is as an ecological link between zooplankton and other fish-eating animals.

**Background Information**

Fertilized herring eggs are demersal (sink to the bottom) and slightly adhesive during the first 24 hours, causing them to stick to rocks and other underwater substrates (Fay et al., 1983; Pardue, 1983). After the first day, the eggs harden and float with the water currents. Larvae and juveniles remain in the river for the summer, feeding on plankton. In autumn, young-of-the-year migrate from nursery areas to the sea where they feed on zooplankton, fish eggs, and small fishes.

Herring remain in the ocean for several years before returning to estuaries to spawn. Female herring are very fecund, each individual producing between 60,000 and 350,000 eggs annually. Although mortality associated with spawning is high for these species, a spawning run can be comprised of up to 50% repeat spawners.

**Habitat Requirements**

Alewife and blueback herring are generally found at shallow ocean depths with water temperatures between 37 and 63 °F. In contrast to American shad which spawn in the River, alewife and blueback herring prefer the tributaries for spawning. As a group, river herring are generally tolerant of a wide range of environments and spawn in both fast flowing streams with sand or gravel substrates and slower portions of streams with detritus or vegetated substrates. Spawning generally occurs when water temperatures reach 51 °F for alewife and 57 °F for blueback herring. Both species show a fairly high tolerance of suspended sediments but can be adversely affected by pollution and low oxygen levels.

#### Hudson River Population

Spawning occurs in tributaries throughout the upper portions of the Hudson estuary. Herring also pass through navigation locks which has resulted in inland populations in lakes, rivers and canals. The herring populations can be maintained by protecting suitable spawning and nursery areas within the tributaries. It is vital to keep freshwater spawning streams accessible to river fish without physical or chemical barriers, maintain adequate tributary water flow, and minimize sedimentation and erosion to protect substrate and water quality.

### *Black Bass*

In addition to numerous anadromous fish species, the Hudson estuary also supports many freshwater resident fish species. Good examples of freshwater resident fishes in the Hudson are small and largemouth bass which together are known as black bass. The black bass, which were introduced into the Hudson in the 1800's, provide an important recreational resource.

#### Background Information

Black bass spawn in spring when the male constructs a nest in shallow water on the lake, river or creek bottom (Smith, 1985). Smallmouth bass nests are located in areas with rocky or gravelly substrate, while largemouth bass construct nests in muddy or silty areas. Up to three females enter the nest and deposit eggs which are fertilized, guarded and fanned by the male. Hatching occurs 1 to 3 weeks later depending on temperature. Newly hatched larvae are guarded by the male for a short period. Young fish feed primarily on plankton and small invertebrates, switching to bigger prey as they grow. Mature bass are opportunistic predators which feed on tadpoles, frogs, fish, crayfish, and insects.

#### Habitat Requirements

Smallmouth bass live in standing water near rocky shorelines and over rocky substrates. Largemouth bass live in warm, vegetated portions of ponds and embayments, and streams with silty bottoms. Both fish tolerate a wide range of environmental conditions, although lower oxygen levels are better tolerated by largemouth bass.

#### Hudson River Population

Little is known about the specific Hudson River black bass populations. Largemouth bass have been the subject of recent research which has located overwintering areas. Largemouth bass tend to school in winter and remain relatively inactive in deeper water near tributary mouths. Smallmouth bass may be particularly limited by suitable spawning habitat due to the daily tidal fluctuations in water level, which may alternately expose or deepen potential nesting sites. This may increase the importance of nesting sites in the Hudson's tributaries. Maintaining or enhancing the black bass population depends on protecting and providing adequate nesting sites.

Although black bass are not native to the Hudson, they are now a major sport fish and an important component of the estuary. These species are sought by many fishermen and support many annual black bass tournaments. The New York State Department of Health currently advises against consumption of largemouth bass.

## Invertebrates

Although the Hudson estuary once supported enormous oyster and other shellfish beds, these resources were destroyed in the nineteenth century through over-exploitation and water pollution. Today, only the blue crab is harvested in large numbers.

### *Blue Crab*

Blue crabs are found in estuaries along the Atlantic and Gulf Coasts. Crabs are esteemed as a food source and are caught both commercially and recreationally.

#### Background Information

Blue crab eggs are carried by the female on the underside of her body until they hatch (Boyce Thompson Institute, 1977). The larvae are free-swimming plankton that undergo several molts over the course of six weeks and feed on zooplankton. During this period, larvae are found both in the lower Hudson estuary and nearby coastal waters. Eventually, the larva molts into a "megalopa" form that crawls along the bottom of the estuary but retains its swimming ability. The megalopa feeds on zooplankton as well as small pieces of fish, shellfish, and aquatic plants. The young move upriver, molting again to become miniature crabs. Both the young and mature crabs are omnivores, feeding on benthic macroinvertebrates, small fish, aquatic vegetation, and dead organisms (Chesapeake Bay Program, 1987). The growth of young crabs is influenced by temperature and is accompanied by a molting process in which the outer shell is shed and a new one is grown. During peak growth periods, crabs can molt every 7 to 10 days. During the molting period, the absence of a hard shell and an increase in metabolism make the crab most vulnerable to environmental stress and predation.

Adult crabs are spatially separated according to sex, with males living further upriver than females. In summer, females move upriver for the breeding season and in fall, return downriver. Although some females may mate in spring and hatch eggs in July, most mate in late summer with hatching delayed until the following spring (Chesapeake Bay Program, 1987). Crabs hibernate during winter in moderate to low salinity waters. The crab's normal life span is three years. Wide-scale fluctuations occur in population levels of crabs, but it is not known whether this is a natural phenomenon or if it is linked to pollution-induced stress.

#### Habitat Requirements

During the summer months, male blue crabs are found in brackish waters with a salt concentration between 3 and 15 ppt. Females prefer more saline waters ranging between 10 ppt to ocean salinity levels. Both male and female crabs are constrained by temperature and grow only in waters that are above 59 °F. When air temperatures drop below 50 °F, crabs move from shallow to deep water and bury themselves in mud to hibernate.

#### Hudson River Population

Blue crabs are found throughout the brackish water portions of the Hudson estuary and less frequently, in fresh water habitats as far north as Catskill Creek. Blue crab abundance appears to have increased substantially throughout the River in 1989, perhaps in response to continued water quality improvement or favorable salinity and weather patterns. Blue crab fishing provides many hours of recreation and the crabs are considered a delicacy. The New York State Department of Health advises against eating more than six crabs per week and suggests discarding the liver and other portions of the crab where toxins accumulate.

## Plants

Although many potentially valuable plants are found in the Hudson River's tidal communities, to date there has been only minimal use of plants other than by fish and wildlife. One exception is rice, which was cultivated in the late nineteenth century. These efforts focused on creating tidal impoundments in which rice could be commercially harvested as an agricultural crop. Today, these impoundments, such as the one near Constitution Island, have reverted to natural marsh. Wild rice is found in many of these habitats, but it is now important only for its wildlife values.

### FURTHER READING

For each of the individual species, the best guides are the references listed within that section including the appropriate **Habitat Suitability Index Models** published by the U.S. Fish and Wildlife Service (where available). Other important references include: **Degraaf and Rudis (1986)** which has brief descriptions of all major vertebrates in New England; and a report from the **Chesapeake Bay Program (1987)** which discusses many estuarine species and provides detailed habitat matrices illustrating the effects of different natural and artificial environmental conditions on both the target species and its significant food sources. Information specific to New York State can be found in: **Andrle and Carroll (1988)** and **Bull (1985)** which provide detailed taxonomic and distribution information about birds in the State (but little or no ecological information); and **Smith (1985)** which contains extensive distribution and ecological information for inland fish in the State. Finally, current information on the status of these species and current management efforts can be obtained through the **New York State Department of Environmental Conservation, Division of Fish and Wildlife**.

## Chapter 3:

# THE RIVER AS AN ECOSYSTEM

---

*In the preceding chapters, ecological communities and species components of the Hudson River ecosystem are briefly presented. It is also important to look at the ecosystem from the perspective of large-scale and long-term effects and processes. Successful protection and management of the Hudson River tidal habitats must recognize the effects of:*

- *Community Interdependence*
- *Ecosystem Cycles*
- *Seasonal Cycles*
- *Long-Term Ecological Processes*

---

## 3.1 Community Interdependence

Although distinct ecological communities are described in Chapter 1, it is essential to realize that any classification system is arbitrary. No matter how different communities within an ecosystem are defined, these communities are not able to function independently. It is the interdependent relationships of communities within an ecosystem which provide it with both natural resiliency and fragility; one of the first responses to stress in an ecosystem is a change in community composition and interaction (Woodwell, 1970).

Species often do not subscribe very well to community classifications. Individual animals and plants are not restricted to one community type but often move to, or are found in, different communities seeking different resources or occupying different roles. Herons, for example, may find nesting sites within upland forest or tidal swamp, yet their food source is found in shallows, mudflats and tidal marsh. In similar fashion, eagles require roosts in large trees of the upland forest community, but feed in shallows and deepwater communities. The anadromous fishes of the Hudson further illustrate the dependence of species on separate communities for spawning, nursery, and feeding needs.

The concept of the interdependence of communities also extends to interdependence among species of different communities. Although speculative, this is exemplified through a possible relationship between muskrats, cattails, purple loosestrife, and turtles. Muskrats live primarily in the upper marsh where they eat cattails; however, they dig their burrows in nearby tidal swamp and upland forest. These burrows are often used by overwintering turtles (Kiviat, 1978). If cattails are replaced by purple loosestrife in the upper marsh, the muskrat population may decline, and the turtle population may suffer due to a shortage of burrows.

In considering the management of an ecosystem such as the tidal portion of the Hudson River, it must be understood that communities and ecosystems are irrevocably interdependent. Protection of the River ecosystem must depend on protection of its component communities and habitats.

## 3.2 Ecosystem Cycles

Another way in which communities are interlinked is manifested through the physical and biological processes which cycle energy and nutrients through ecosystems. Energy is produced either within the system through photosynthesis or brought to the system in the form of organic matter. *Limiting* nutrients are scarce elements or compounds which determine the level of primary productivity that can be supported by the ecosystem.

### Primary Productivity and Energy Flow

An important factor that determines how an ecosystem functions is the source and amount of available energy. The organic materials produced through photosynthesis, which captures energy from the sun, provides the energy that supports most ecosystems. Energy is measured by *net primary productivity* which is defined as the organic material stored by producers in excess of their own metabolic needs.

The origin of this organic material can either be autochthonous (produced within the ecosystem) or allochthonous (produced outside the ecosystem). In terrestrial ecosystems and lakes, production of organic material within the ecosystem tends to dominate the flow of energy. In rivers, however, the role of organic material that is not produced within the ecosystem can be dominant (Hynes, 1970).

In the Hudson Estuary, terrestrial input of organic matter dominates the system. In fact, respiration of producers and decomposers exceeds the autochthonous production by plankton in the River (Howarth, 1989). Terrestrial sources of organic matter in order of importance include agricultural runoff, urban runoff, and sewage. Although the estuary is dominated by terrestrial input of organic matter, local conditions are strongly affected by autochthonous production associated with plankton, wetlands (marshes), and submerged vegetation.

*Plankton*, the minute plants found floating in the water column, are the dominant primary producers in many ecosystems including the open ocean, coastal waters, and many lakes. On the Hudson River, however, it appears that net productivity of plankton is relatively low, probably due to a combination of turbidity and turbulence which reduces the amount of photosynthesis to levels that are only slightly above the amount necessary to support the metabolic needs of the plankton (Hynes, 1970; Cole et al., 1989).

*Marshes*, the second source of primary productivity, are among the most productive habitats in the world. Marshes may have a productivity of over 2000 $g/m^2/yr$ in comparison with other temperate ecosystem productivity values of approximately 1000 $g/m^2/yr$ for forests; 750 $g/m^2/yr$ for cultivated lands; and 200 $g/m^2/yr$ for deserts (Odum et al., 1984; Tiner, 1985a). Although these numbers may not apply directly to the Hudson River, they illustrate the importance of marshes, especially since much of the biomass produced is exported as an energy source to adjacent shallows, mudflats, and deepwater communities.

The last source of primary productivity is associated with mudflats and shallows of the River that are densely covered with *submerged vegetation* throughout the warmer months of the year. Although the productivity of submerged aquatic plants is generally lower (approximately 600 $g/m^2/yr$) than either lower or upper marsh communities, undoubtedly these beds of aquatic plants contribute large amounts of organic matter to the ecosystem (Westlake *in* Wetzel, 1975). The extent of submerged aquatic vegetation beds and their productivity on the Hudson are not known. Recent research suggests that the amount of productivity associated with submerged vegetation in the Hudson is extremely low (Garrit, 1989). Although evaluating productivity of submerged plants is a difficult task for a variety of reasons, high rates of production are often found for submerged aquatic vegetation in rivers (see Hynes, 1970). Further research should be conducted with respect to the role of submerged vegetation on primary productivity on the Hudson, since these plants may play a large role in the productivity of the estuary.

In addition to primary productivity in the ecosystem, another important consideration is the transfer of energy between different levels of the food web. Energy is transfered in the form of plants that are consumed directly by herbivores, or indirectly in the form of dead organic material or *detritus,* which is consumed by zooplankton, benthic organisms, bacteria, and other consumers and decomposers. These consumers support the next level of animals, which support the first level of predators, which may in turn be eaten by other predators.

Energy transfer also differs within each community. Plants of the lower marsh and shallows tend to decompose much more rapidly than plants of the upper marsh (Odum et al., 1984). Because of these different decomposition rates, energy tends to flow out of lower marsh for most of the year, whereas upper marsh serves as a nutrient sink with a net inward energy flow for most of the year. The capacity of upper marsh to absorb excess nutrients enables the marsh to serve as a natural sewage treatment plant and to moderate excess productivity in the ecosystem (Odum et al., 1984).

### Nutrient Cycles

In addition to energy, plants and animals require nutrients including carbon, nitrogen, and phosphorus.

The carbon cycle is similar to the ecosystem's energy cycle since plants convert carbon dioxide from the atmosphere into organic molecules that are the basis of the food web. In addition to carbon being assimilated into the ecosystem through primary productivity, carbon also enters the ecosystem from allochthanous sources (produced in another ecosystem) including dead organic matter carried by tides or watershed runoff, and live organic matter such as eggs from anadromous fish returning from the ocean.

Carbon that enters the food web is eventually released to the atmosphere (as methane or carbon dioxide) or deposited as sediments (forming peat, fossil fuels, and carbonate rock). Most carbon, approximately ninety-nine percent, is contained in sediments. Living organisms are the source of this sedimentary carbon reservoir; for example, most of the world's limestone probably originates from biological processes (Kormondy, 1976).

In the Hudson River, carbon is mostly incorporated in the ecosystem through the vegetation of marshes, shallows, and mudflats, and the forested uplands of the watershed. These plants, as well as the River's plankton and the external sources of carbon, provide the foundation for the ecological importance of the Hudson River.

Nitrogen is cycled through the ecosystem quite differently than carbon. Where carbon is relatively scarce in the atmosphere (0.03 to 0.04 percent), nitrogen is abundant (79 percent). The gaseous form of nitrogen, however, is not usable to most organisms. Gaseous nitrogen must be transformed or fixed in an inorganic form such as nitrate or ammonia before it can be used in biological processes. Most nitrogen fixation is accomplished by the biochemical action of bacteria and fungi, mostly in symbiotic relationships with higher plants. Nitrogen fixation requires energy from carbon compounds; the symbiotic relationship between plants and nitrogen-fixing organisms is based on plants exchanging carbon compounds for biologically usable nitrogen.

In addition to biochemical nitrogen fixation, industrial nitrogen fixation for the production of fertilizers almost equals the total amount of nitrogen fixed by all natural sources. The global nitrogen cycle is out of balance, with the amount of nitrogen taken from the atmosphere exceeding the amount being returned. The resulting excess in biologically available nitrogen is contributing to an increase in nitrogen compounds in ground water, rivers, lakes, and the ocean (Kormondy, 1976).

Sources of nitrogen supplied to the Hudson estuary include direct fixation of atmospheric nitrogen, decomposition of organic matter in sediments and in the watershed, and runoff of fertilizers. The maximum input of biologically usable nitrogen occurs in the spring and early summer, corresponding to the period of highest demand for plant growth. Aquatic plants of the marshes, shallows, and mudflats remove nitrogen from the river during the growing season and release nitrogen during the fall and winter months, serving as effective regulatory reservoirs (Odum et al., 1984). In addition to this regulatory function, nitrogen is removed from the cycle through sedimentation of decomposition-resistant organic matter, particularly from the emergent plants of the upper marsh.

In comparison with the other major nutrients, phosphorus is least abundant, and the most likely to limit biological productivity. Natural sources of phosphate are produced by weathering of phosphate-bearing rocks and decomposition of organic matter. Additional sources of phosphorus include fertilizers, domestic sewage, stormwater runoff, and detergents; all originating from human activities. Land use and management practices in forestry, agriculture, and in urban areas are all directly related to both nitrogen and phosphorous loading to the aquatic environment (Wetzel, 1975). Urbanization increases phosphorous discharges to surface waters in approximately direct proportion to increases in population densities (Weibel, 1969).

The availability of carbon and nitrogen generally far exceeds that of phosphorus in aquatic environments. Given enough light and other favorable conditions, the availability of phosphorus will be the first limiting nutrient to biological productivity. When phosphorus is introduced to an aquatic system, this limitation is removed and the level of photosynthesis can increase dramatically resulting in increased productivity or *eutrophication* of the system. Excess productivity can be detrimental, eventually resulting in algal blooms and oxygen depletion. Extreme examples of cultural eutrophication include the "death" of Lake Erie and the annual formation of the anoxic "Albany pool" in the Hudson estuary in the 1970's.

As in the nitrogen cycle, the phosphorus cycle is regulated by aquatic plants with an uptake of phosphorus in spring and a release of phosphorus accompanying the decomposition of plants in fall. Phosphorus is released from decaying plants within a matter of days, and is quickly used by bacteria and algae or lost to the sediments (Wetzel, 1975). Inputs of phosphorus can be controlled by reducing use of fertilizers, advanced sewage treatment, maintaining natural vegetation cover, limiting erosion and controlling surface water runoff.

## 3.3 Seasonal Cycles

The seasonal changes in appearance, structure and ecology of communities are important factors to consider in an examination of the Hudson River ecosystem. For example, at the beginning of spring, the substrate in the tidal marsh is mostly bare muck containing only roots of perennial plants and seeds of annuals. During summer, a series of different plants dominates the canopy structure, dramatically changing the appearance of the marsh. In autumn, plants begin to die and by the onset of winter, only the dead stems remain to be broken up slowly by snow and ice, providing the detritus that is so important in cycling carbon in the estuary (Odum et al., 1984).

Significant seasonal changes also occur in creeks, shallows, and deepwater. In spring, huge populations of fishes enter the River from the ocean, seeking spawning grounds and, in the form of eggs and their own bodies, bringing a concentrated abundance of nutrients gathered from the ocean. After spawning, the adults either return to the ocean, or die, leaving their offspring to forage and grow in the River's nursery areas. During fall, the young of many of the fish species may migrate to the warmer waters of the lower estuary or the ocean, leaving only resident fish species to remain beneath the ice of the upper River over winter.

Recognition of the seasonal cycles of nutrients, productivity, and species presence and abundance is essential for effective management of tidal habitats. For example, dredging has much less impact on some fish populations if it is conducted during the late summer and fall to avoid sensitive spawning periods. Likewise, factors that determine the distribution of a rare plant may not be evident in summer, when the plant is growing, but instead might reflect winter scouring of the substrate by ice floes or perhaps autumn flooding by high tides or runoff that wash away seeds before they can germinate. Although much of the information provided in this report focuses on the most productive stages in the ecosystem, it is crucial to recognize that the ecosystem continues to function throughout the year and that its species must survive the changes that occur with the seasons.

## 3.4 Long-Term Ecological Processes

Another important consideration for management and protection of the Hudson's tidal habitats is the effect of long-term processes on the ecosystem. One such process is natural succession. In the classic freshwater non-tidal system, a marsh is a transition stage between open water and land that occurs after a lake or pond has begun to fill in with sediments and organic materials. The marsh subsequently gives way to either a meadow and different types of forest or to a bog system (Wetzel, 1975; Mitsch and Gosselink, 1987). Similarly, saltwater tidal marshes may also represent a stage in ecological succession, with the low marsh gradually becoming high marsh (Frey and Basan, 1978). In the case of tidal freshwater and brackish marshes, a similar process may occur with lower marsh gradually evolving to upper marsh and upper marsh gradually becoming swamp forest. Although this process of succession has not been demonstrated for the unique conditions found in the Hudson's freshwater tidal marshes, preservation of marshes in their current state may not be desirable or practical if these same marshes are undergoing a natural process of succession. If, however, succession is linked to human actions, such as erosion and subsequent siltation due to development, then it would be correct to seek restoration of the area and to establish protective measures to allow the community to evolve naturally, or remain the same, as appropriate. It is likely that an investigation of succession on the Hudson would show that relatively sheltered areas may be undergoing succession that has been accelerated by human actions, while the succession process may not be evident in marshes, mudflats and shallows that are more exposed to River currents, tides and ice floes.

Another aspect of succession on the Hudson is the formation of marshes, mudflats, and shallows through *shoreline erosion.* As easily eroded land recedes, flats and shallows are formed which may evolve to marshes. Examples of this process exist in the Stockport Creek and Flats habitat. A similar succession process that involves shifts in the physical locations of communities would most likely occur with shifting of River channels. Newly formed backwaters would be rapidly colonized and may then undergo the process of succession from shallows to mudflats or marsh (see Figure 22 for an illustration of this phenomenon over the last century). Similarly, new areas of deepwater can also be formed at the expense of shallows and mudflats, a process that would be accompanied by corresponding changes in community composition in the opposite process of succession known as retrogression.

The location of communities also depends on an even longer time scale that reflects changes in the ocean. As sea level slowly declined during the last ice age, tidal communities moved with the shore. Evidence of these communities can be found on the ocean bottom several hundred miles seaward of today's shoreline. Conversely, at the end of the last ice age, river mouths were drowned and the tidal communities retreated in front of rising sea levels. Although the current marsh communities have occupied their present positions for less than 15,000 years, this community type has been in existence for much longer. Fossil evidence indicates that the functional equivalents of modern freshwater tidal marshes have existed for several hundred million years and have been constantly moving with tidal rivers (Frey and Basan, 1978; Odum et al., 1984).

The effect of these long-term processes on the ecological communities has profound ramifications for conservation efforts. In addition to preserving the ecosystem from acute threats due to human action, it is also important to provide space and resources necessary for communities to respond to changes in the environment. A marsh that is threatened by rising water level and the attendant increases in currents and erosion, cannot retreat if it is thwarted by a bulkhead that prevents the adjacent upland from flooding. If all land adjacent to existing marsh is developed, there will be no suitable substrate to support survival of the marshes, if sea level should rise as is expected to occur over the next century due to the greenhouse effect. Ironically, while it is human-induced change to the environment that currently threatens the Hudson's tidal communities, it may well be human resistance to change in the environment, through shoreline fortification against rising sea level, that constitutes the greater threat.

**FURTHER READING**

The most useful source on the general ecology of the freshwater tidal ecosystem is **Odum et al. (1984)**. Introductory ecology texts such as **Whittaker (1970)** or **Kormondy (1976)**, or a limnology text such as **Wetzel (1975)** provide additional detail regarding the topics briefly presented in this chapter. For ecological information about the Hudson River, works by **Kiviat (1978 and 1979)** are valuable sources.

Chapter 4:

# HUMAN INTERACTIONS WITH THE RIVER ECOSYSTEM

*Human activities along the Hudson River that affect the Hudson River tidal habitats are examined in this chapter. The first section presents an historical overview of the interaction between humans and the River. Subsequent sections review human activities affecting the River, focusing on issues, practices, and impacts concerning the River habitats, and ways in which adverse impacts can be minimized in the future. Human activities and impacts covered include:*

- *Chronology of Hudson River Use*
- *Water Use and Management*
- *Pollutant Discharges*
- *Transportation*
- *Shoreline Development*
- *Use of Living Resources*

## 4.1 Chronology of Hudson River Use

Knowledge of the history of human activities that have worked to shape the River is central to understanding human interactions with today's Hudson River ecosystem. For hundreds of years, the Hudson River and the surrounding valley have had an enormous physical, strategic, economic, and cultural impact on its inhabitants and the nation (Mylod, 1969; Boyle, 1979).

*Pre-European Period (?-1609)*

Archaeological evidence indicates that the Hudson Valley was settled several thousand years ago by tribal peoples collectively called the Algonquin. Legend has it that the Algonquin came from the west and fulfilled an ancient prophecy by ending their nomadic journey at a great stream with "water that flows two ways." Algonquin tribes ranged from the Mohicans near Albany to the Wappingers and Manhattans along the east shore of the River and the Wawarsings, Haverstraws, Tappans, and Raritans along the west shore.

Living standards in Algonquin villages seemed to be relatively high compared to surrounding native tribes due to the resources of the Hudson Valley, including abundant food plants, game animals, and fish and shellfish. In addition, villagers grew corn and other crops in small clearings, conducted extensive trade, and used mineral resources to produce copper beads and other art works. The Algonquin lifestyle had its negative aspects such as losses to slave-taking raids by the more warlike tribes of the western Iroquois federation. Nonetheless, most accounts of these earliest inhabitants of the Hudson valley describe a prosperous people who had little effect on their natural surroundings.

*The Colonial Period (1609-1776)*

Exploitation of the Hudson River ecosystem began with the activities of european settlers. The mouth of the Hudson was discovered in 1524 by Giovanni da Verrazzano but the first documented European exploration of the River was in 1609, led by Henry Hudson sailing for the Dutch on the Half Moon. Although Hudson failed to find a northwest passage, he brought back reports of a land "as pleasant as one can tread upon" that "is the finest for cultivation that I ever in my life set foot upon, and it also abounds in trees of every description" (Hudson, 1609 *in* Van Zandt, 1971). In similar fashion, Hudson's second mate, Robert Juet, described the surroundings as being "full of great and tall Oakes," having excellent fishing so that they could take "foure or five and twentie Mullets, Breames, Bases, and Barbils and return in an hour," and containing mineral wealth in a "cliffe that looked of the colour of a white greene, as though it were either Copper, or Silver" (Juet, 1609 *in* Van Zandt 1971).

In 1613, plans were made to establish a colony which culminated in the creation of the Dutch West India Company in 1621 and colonization of the southern portion of Manhattan Island. In 1626, Manhattan was purchased from its original occupants for the fabled $24 price. During this time, Fort Orange was established at what is now Albany to serve as a military outpost and trade center, focusing on the lucrative fur trade. In 1630, to stimulate settlement, the patroon system was established in which a massive land grant was given to anyone who would finance a settlement of fifty or more people. Beginning with Kilaen van Rensselaer, much of the valley became incorporated into large estates. In the mid 1650's the British became jealous of the power held by the Dutch and in 1664, New Amsterdam was seized in a bloodless coup and renamed New York. At this time, the population of the colony was a scant 8,000 settlers. A century later, at the start of the revolution, the population was 168,000. With the growth in population came settlement of the wild lands which were first logged and then farmed.

*The Military Period (1776-1812)*

Throughout the Revolution and the War of 1812, the Hudson River was of strategic importance in the military campaigns that formed the nation. In the Revolutionary War, the Hudson River served as a main artery for trade, information, and military supplies. At the outset of the war, the British designed a strategy to sever the colonies by sending General Clinton north from New York City to meet General Burgoyne coming south from Canada. Although Clinton was able to march as far north as Clermont, Burgoyne was stopped in a decisive battle at Saratoga that marked the turning point of the war.

Upon Clinton's retreat, the Americans regained control of the River and built fortifications at West Point including a great chain that was stretched across the River to impede naval attacks. In the last years of the Revolution, West Point became the command center for the American army. In the War of 1812, Americans vigorously defended the mouth of the Hudson, preventing attack from blockading British ships. In support of these wars, the ship building industry along the River flourished, with the construction of numerous privateers and other boats. During the entire military period, the munitions industry was also thriving in the Valley, along with fur trade, agriculture, and even a whaling fleet based at the City of Hudson.

*Commerce and Industry (1807-1888)*

With Fulton's steamboat journey to Albany in 1807 and the completion of the Erie Canal in 1823, the Hudson River and New York State became more important to the nation's economy, serving as the conduit between the resources of the western frontier and the cities of the eastern seaboard. This transportation system became even more important in the 1840's with the construction of rail lines along the Hudson River's shores. The wealth that flowed down the Hudson from other regions was supplemented with considerable resources originating from the River Valley. In the first part of the 19th century, the Hudson became a center for brick making, hide tanning, cement production, ice cutting, fishing, and agriculture. As a result of this commercial activity, waves of new immigrants came to the Hudson Valley. Burgeoning commerce and population levels began to place significant stress on the River's tidal habitats.

Over time, many of the industries along the Hudson declined. Resource-dependent industries were doomed by their own success which led to overexploitation of natural resources (e.g. the hemlock bark needed for tanning). In other cases, the demand for the product collapsed (e.g. the invention of refrigeration eliminated the need for ice-cutting). As a result, many factories and towns along the River were unable to survive economically. In addition, water-based transportation was replaced by the railroad (and later by highways). In 1888, the first rail bridge was completed over the Hudson at Poughkeepsie, allowing direct shipment of goods through the region, and marking the end of the glory days of Hudson River commerce.

*Art and Recreation (1823-1963)*
Even while industry and commerce of the Hudson valley was at its height in the 19th century, the Hudson valley and the nearby Catskill mountains also became host to vacation homes and resorts for upper class residents of New York and other cities. A burgeoning tourist industry was led by the Catskill Mountain House which began as a small cottage in 1823 and developed into a world class resort for the rich and famous. The numerous visitors to and residents of the Valley included artists of the Hudson River School who attempted to capture in their paintings the essence of the landscapes they saw. The River and mountains also inspired authors such as Washington Irving and James Fenimore Cooper.

In the latter part of the 19th and early 20th centuries, recreational use of the River valley extended to the middle class. Numerous summer camps were established in the River valley and in the Catskills. An important annual event in the early part of the twentieth century was the Intercollegiate Rowing Association Regatta held at Poughkeepsie. Hundreds of spectators viewed the regatta from the banks of the River, other boats, and even a specially built railcar.

Although dominance of the Hudson River valley had declined in American industry, agriculture, and military importance, it continued to make important contributions with its many cement plants, extensive fruit orchards, military use at Iona Island, and the Air Force headquarters at Stewart Field. In addition, the River became host to new industries including oil and nuclear power plants, a shipping industry centered on petroleum products, and electronics manufacturing plants. Overall, however, the region had become a bucolic backwater removed from the hustle of the modern world. And eventually, even the cultured aura surrounding the Hudson and the Catskills began to fade, symbolized by the slow breakup and final burning of the Catskill Mountain House in 1963.

*Awareness of the Natural Ecosystem (1963 to present)*
In the past quarter century, an awareness of the environment has evolved in the Hudson valley. This movement began in 1963 with organized opposition to a power facility proposed at Storm King Mountain.

Since 1965, when plans for the power plant were halted and the Storm King controversy ended, the environmental movement has grown stronger in its efforts to protect the natural heritage of the River. Notable milestones include the 1965 decision of the Hudson River Fisherman's Association to aid in enforcing restrictions on pollutant discharges in the River, construction of the Hudson River Sloop Clearwater in 1969, passage of the Federal Water Pollution Control Act in 1972, cessation of PCB disposal in the River by General Electric in 1977, and the agreement between utilities and environmental groups that established the Hudson River Foundation in 1981.

FURTHER READING
The information contained in this section is adapted from **Mylod (1969)** and **Boyle (1979)**, two excellent and entertaining histories of the Hudson River. Additional information was also taken from a short history by **Dyson (1968)**. A brief history of the Hudson River Valley supplemented with many outstanding photographs of the region can also be found in **Scheller (1988)**.

## 4.2 Water Use and Management

The Hudson River's water is its most important resource. Water from the Hudson is used in all facets of human life including drinking, bathing, swimming, boating, food processing, industry, fire fighting, commercial and institutional uses, irrigation, power generation, navigation, recreation, waste transportation and dilution, and maintenance of fish and wildlife resources.

Recent growth in the region's human population has been accompanied by a corresponding increase in competition between different users of the water resource, a problem that is expected to increase in the future. In 1976 there was an estimated freshwater demand of over 745 million gallons a day (mgd) in the Hudson River Watershed. Demand was projected to increase to 907 mgd by the year 2000 (Hudson River Basin Study Group, 1979a). Sewage effluent discharge has been increasing proportionately. Given the magnitude of the demand for water, existing and future water consumption must be carefully planned to meet both human needs and the River's tidal habitat requirements.

## Water Withdrawals

Water use can be divided into two main types: *out-of-stream uses* that divert the water from the river or tributary channel and *in-stream* uses that keep water in the system. Within the category of out-of-stream uses, water withdrawals can be further subdivided into *consumptive* and *non-consumptive* uses. Non-consumptive uses are those in which the water is withdrawn and then returned to the system, such as in the generation of hydroelectric power. Consumptive uses are those in which the water is removed from the system, such as in crop irrigation. The significance of impacts from consumptive and non-consumptive water withdrawals depend on the amount of water removed, the mechanism by which the water is removed, and pollutants returned to the system.

### *Issues and Practices*

*Municipal Water Supplies*

Eight communities depend on the Hudson for their public water supply. These communities are located in the middle section of the River where water has been the cleanest and most potable. The largest user is the City of Poughkeepsie which takes about 10 mgd (compared to an 8919 mgd average flow of freshwater into the River). Municipal water systems along the River are about 90% non-consumptive, returning most of the water to the River through sewage systems (Barclay, 1988). Direct removal of water by these communities does not result in large losses of water, although water quality is diminished.

Direct removal of water from the River is a major issue with respect to water supply plans for New York City. New York City has applied for a permit to take 100 mgd during drought from an intake near Chelsea, Dutchess County, and ultimately to obtain between 300 and 1200 mgd from this and other withdrawal points on the River. Unlike local water system usage, water use by New York City is primarily consumptive (Barclay, 1988). Water is taken from the freshwater portion of the estuary, and after being used, is discharged through sewage outlets in the saltwater section of the estuary. The effect of removing such a large volume of freshwater from the system is largely unknown, but it would likely result in salinity alterations and changes in habitat use and value.

*Power Generation and other Industrial Uses*

Although some industrial plants and factories draw their water from public systems, the majority of industrial users take their water directly from the River. Foremost among these industrial consumers are power plants that require huge volumes of water for cooling. The amount of water that is required depends largely on the power output and the type of cooling system. *Closed-cycle* power plants include a complex cooling tower and use much less water than *once-through* systems that use a continuous supply of water (Hudson River Basin Study Group, 1979b).

Seven large power plants operate on the Hudson Estuary. These plants operate on fossil fuels with the exception of the nuclear plants at Indian Point. There are a total of 21 generating units, all of which have once-through cooling systems with a combined maximum cooling water intake of 6199 mgd. This is more than two-thirds of the 8919 mgd average annual freshwater flow into the estuary. During summer, when the freshwater flow is significantly less, water withdrawals can exceed the net freshwater flow. In addition, 88 percent of water withdrawal occurs within the 28 mile stretch of the River immediately upriver from Haverstraw Bay, concentrating the effects of water withdrawals (McDowell, 1985).

### *Impact of Water Withdrawals*

*Entrainment and Impingement*

Removal of water from the River is most damaging to fish and other swimming or floating animals and plants. At large water intakes for power plant and municipal systems, the force of water rushing into the intakes sucks small organisms such as phytoplankton, zooplankton, and fish eggs and larvae into the system in a process termed *entrainment*. Larger organisms such as fish are trapped against filter screens in a process known as *impingement*. In both processes, the organisms can be either killed or suffer damaging chemical and physical stresses that lead to subsequent increased mortality rates (McDowell, 1985).

Entrainment effects are critical with regard to survival of anadromous fish eggs, larvae, and juveniles. The entrainment effects are exacerbated by the "two steps forward, one step backwards" nature of the River's tidal flow which means that organisms are vulnerable to entrainment several times as they are washed back and forth near an intake structure (Barclay, 1988). Impingement can lead to reductions in fish populations directly by killing spawning fish or indirectly by tiring them as they escape from the intake so that they cannot complete their upstream migration. The effects of impingement can be partially mitigated with specially designed screens that guide the fish to a bypass around the system or by other devices that collect fish from the system (Fletcher, 1984).

*Salt Front Movement*

The loss of water from consumptive uses at any location along the Hudson can change the ecosystem. Reducing the amount of fresh water in the freshwater portion of the River will cause the location of the salt front, the intermixing zone between salt and fresh water, to move farther north. The United States Geological Survey (USGS), in cooperation with the DEC and New York City, is undertaking a four year study of the salt front movements. Although the mechanisms of salt front movement and its importance to the River ecosystem are not well understood, altering the physical environment created by the salt front holds great potential for adverse impacts on the ecosystem. Negative impacts would be especially acute during droughts when withdrawals would move the salt front further upriver than would occur under natural conditions.

The existing seasonal changes in salinity that accompany the natural movement of the salt front may be important factors in the function of the ecosystem. Problems are likely to occur when artificial change does not correspond to the changing season or if the change exceeds natural geographic limits. Anadromous fish, particularly those that spawn near the salt front, may depend on the existing combination of salinity and substrate which may not be available if the salt front location were changed. Freshwater areas would also be inundated by brackish water, resulting in the death of freshwater plants and animals and a radical change in community structure.

Movement of the salt front might drastically change productivity in the ecosystem. For most of the year the salt front, and its associated nutrients, is located in the Tappan Zee/Haverstraw Bay area where broad, shallow waters allow sufficient sunlight for plankton and extensive beds of submerged plants. If the salt front were to move north to the narrower and deeper region of the Highlands, no corresponding productive shallow area would exist and the habitat values associated with the Tappan Zee and Haverstraw Bay area would not be replaced.

The ecosystem of the Hudson River at New York City would also be affected by the proposed water withdrawals. Fresh water discharge into the brackish water via the city sewage sytem could easily have detrimental effects as salt-tolerant species are exposed to fresh water.

*Thermal Pollution*
Returning water to the River after it is used is desirable in that it maintains flow. Problems arise when the water contains pollutants such as excess heat in power plant cooling water. Power plants operating along the Hudson each discharge water that has been heated between 6.7 and 17.8 °F, with most discharging in the upper end of that range (McDowell, 1985).

Excess heat can alter the natural conditions of the river environment, resulting in pronounced effects on thermally sensitive organisms such as fish that only spawn within a narrow temperature range. Thermal polllution can also delay normal freezing, throwing off cycles of overwintering plants and animals. Atlantic tomcod, which spawn in winter and generally thrive in colder waters, may be the organism that is most affected by thermal pollution. The Hudson is the tomcod's southernmost breeding ground. Increasing water temperature alters the River so that it resembles the more southern environments that tomcod cannot tolerate and may seriously affect the tomcod population (Fikslin and Golumbek, 1979).

Adverse impacts from thermal pollution become severe when temperature levels fluctuate widely, usually when warm discharges are quickly stopped between late fall and early spring when ambient water temperatures are low. Fish are cold-blooded organisms that cannot rapidly adjust to radically different temperatures. When a plant causes temperature to rise abruptly, fish acclimated to the colder water can be killed. Conversely, when temperature drops suddenly, fish acclimated to warm water from the plant discharge may die or be immobilized while their systems attempt to adjust. Thermal pollution can have beneficial effects including providing open water areas for overwintering waterfowl, concentrating game fish, or raising the productivity of certain organisms.

***Habitat Protection Measures***
Adverse impacts of water withdrawal on habitats are best mimimized by reducing the amount of water withdrawn. New York State law requires short and long term water conservation programs as a condition for all new water supply permits. In addition, the NYS Water Resource Management Strategy for the Delaware/Lower Hudson region states that water conservation should be of primary concern in planning for the future. Water conservation measures can include the use of low flow plumbing fixtures, universal metering, a price structure that encourages conservation, leak detection and control programs, limitations on lawn watering, public education programs, reuse of waste water, and reuse and recycling by industry (Barclay, 1989). Increased water conservation has the additional benefit of reducing the volume of water flowing into sewage systems and improving municipal treatment programs. Large industrial users, especially power plants, can also reduce water withdrawals by employing closed-cycle cooling systems. Water containing waste heat, which has traditionally been pumped back into the River, could be used to heat industrial complexes and nearby offices and residences.

Large users can reduce impacts of their intake structures by locating them away from productive fish spawning and nursery grounds, development of effective intake barriers, and scheduling water withdrawals to avoid sensitive spawning and migration periods. Multiple use intakes could also be developed that would reduce both the number of intakes and the cost for mitigating impingement and entrainment impacts.

Demands for water for the NYC metropolitan area pose a significant challenge. New York City's existing proposal for Hudson River water withdrawals calls for taking an unprecedented amount of water during drought to supplement reservoir supplies. Emergency withdrawals during periods of drought would remove water from the River at a time when tidal communities are undergoing stress due to naturally low seasonal flows. Seasonal effects of low water flow are already compounded by existing diversions from Hudson River tributaries to the New York City reservoir system. A second water withdrawal proposal would expand the role of the Hudson from a seasonal supplement to a continuous, large-scale supply. Negative environmental impacts must be carefully evaluated before large-scale withdrawal projects are approved. Results of the USGS salt front study may help determine likely changes that would occur in the environment. This information will then have to be used in additional ecological research on the River's tidal communities and populations before decisions regarding large-scale withdrawals should be made.

Proposals to withdraw significant quantities of water for consumptive uses must factor in the major impacts on the ecology of the estuary that are likely to occur. Implementation of these proposals may very easily destroy ecological relationships, such as the timing of fish spawning with the movement of the salt front over unique substrates, that have been evolving since the passage of the last ice-age. Given the uncertainty of the magnitude of impacts resulting from water withdrawals, any additional withdrawal should be permitted only after strict conservation measures have failed to meet water demand.

**FURTHER READING**

An older discussion of water resource issues in the Hudson Valley can be found in the two reports produced by the **Hudson River Basin Study Group (1979a,b)**. More recent information on water issues can be found in recent studies by the DEC Division of Water such as **Hazen and Sawyer (1987)**. For a complete history of the controversy over power plants along the River, see **McDowell (1985)**. A technical review of mechanisms to prevent impingement of fish on large intake systems can be found in **Fletcher (1984)**.

## Dams and Water Impoundments

Direct removal of water from the River is only part of water use in the Hudson Valley. Much of the water that would normally flow to the Hudson River is diverted from tributary streams for municipal use, hydroelectric power generation, the barge canal system, flood control, and crop irrigation. The water supply system is based on a network of dams, reservoirs, canals, and aqueducts.

### *Issues and Practices*

*Water Supply*

Water supplies are primarily managed using reservoirs to store runoff until it is needed. As of 1979, there were 37 reservoirs in the Hudson River watershed with a capacity of 1 billion gallons or more, and many more smaller ones (Hudson River Basin Study Group, 1979b). Reservoir capacities are measured in acre-feet of water with one billion gallons of water equalling 3060 acre-feet. The largest reservoirs along the Hudson include Sacandaga Lake at 880,000 acre-feet and Ashokan reservoir at 390,000 acre-feet.

Three hundred ninety two municipal water supply systems are located on the lower portion of the Hudson Valley (including parts of the Delaware watershed). Largest among these are the New York City and Jamaica water supply districts (Hazen and Sawyer, 1987). As early as the nineteenth century, New York City planned for its future water demands, acquiring land and water rights in upstate counties. Under the 1905 Water Supply Act, New York City was permitted to expand its water supply system, subject to the condition that water would be supplied at cost to county water districts. This condition led to New York City's role in regional water supply.

The water supply system is comprised of a network of aqueducts and reservoirs that bring water to the southern portion of the State, bypassing normal tributary flow and reducing input into the Hudson River. Although a small amount of water is brought into the Hudson watershed via inter-basin transfer points, overall, the water supply system reduces the net flow of freshwater in the tidal habitats and dampens fluctuations in water level.

*Hydroelectric Power*

As of 1979, over 38 hydroelectric plants were in operation on tributary streams in the Hudson River Basin, producing an annual average of 4.8 million kilowatt-hours of power. Hydroelectricity is also produced at the main dam on the Hudson River at Troy and many other potential sites have been identified for hydropower generation.

Hydroelectric power uses the force of water flowing in the river or from higher elevations to turn turbines in a magnetic field to generate electricity. The least disruptive method of power generation is run-of-river generation. Power is generated when precipitation and runoff in the watershed produces overspilling in reservoirs or increases the flow rate in rivers and streams. Since power is generated when water flow increases, discharges simulate natural fluctuations in downstream watercourses.

*Water Level and Flood Control*

Dams are also used to control flow of water in the River by storing water from snow melt and heavy rains and releasing it during drier periods. In the Hudson River system, the most important flood control dam is at Sacandaga Reservoir. Prior to construction of dams, spring snowmelt created high water flow and flooding in the River basin while late summer droughts caused severe reductions in fresh water flow. The Sacandaga dam, the Federal dam at Troy, and other water impoundments have dramatically reduced the severity of spring flooding, and led to increased flow and improved water quality during dry summer months.

Despite these control measures, flooding still occurs in the Hudson Valley. Localized floods can be caused by ice jams in early spring that form temporary dams which raise water levels above the River and stream banks. Throughout the Hudson's watershed, general flooding is caused by deforestation and development, which reduces the ability of the watershed to retain water and results in rapid water level rise in tributaries. Damage to structures frequently occurs when development is allowed in flood-plains which are subject to inundation at 10 year and 100 year flood levels.

### *Impacts of Dams and Impoundments*

#### *Reduced River Flow*

The primary impact of water control systems on the River is reduced water flow, causing a shift in the location of the salt front in the same way that direct removal of water from the River does. It is likely that the normal range of movement of the salt front has been reduced by the water control systems in the Hudson watershed. Dams decrease water velocity in the River and the associated scouring effect of floods on the River bed. Water entering a reservoir loses velocity, and when water is released from the dam, its sediment load is left behind, reducing transport of sediment to the estuary. Of the above-listed impacts, it is difficult to determine whether they are positive or negative, particularly since the watershed has been altered by deforestation and development and the reulting sediment loads have increased due to runoff and erosion. A clearly negative impact associated with impoundments is reduced water quality. Water released from impoundments is generally warmer, contains less dissolved oxygen, and may have higher nutrient levels when compared to natural runoff.

#### *Tributary Impacts*

Although the Hudson estuary is not dammed for most of its length, there are many dams on its tributary streams. When dams store or divert tributary waters, their valuable freshwater input is lost. Indeed, many of the River's significant coastal fish and wildlife habitats are located near the mouth of tributaries where environmental conditions associated with freshwater inflow has led in part to the ecological value of the areas.

Dams also block access to anadromous fish spawning grounds in the tributaries. Although the area of freshwater creeks accessible to fish is only a small fraction of the estuary, this habitat is the most important for many anadromous fish species that require clear, fast-moving water with adequate substrates for successful spawning. Tributaries are also important to anadromous fish such as American shad that spawn in the River, since suitable spawning conditions exist near the mouths of tributaries. When a tributary is dammed, the flow of water is reduced in important downstream areas and upstream habitat is not available for spawning. Depending on the amount of water diverted, the tributary can be transformed into silty river bottom with little value for fish spawning. As an example, the Croton River now has limited value as a fish spawning area since most flow is diverted.

### *Habitat Protection Measures*

It is unlikely that new dams will be built on the Hudson River or its major tributaries. If such proposals are made, the impacts described above should be carefully considered. The need to increase reservoir capacities, and thus further divert basin runoff from the River, can generally be reduced by employing water conservation measures. New hydroelectric generation facilities should be limited to run-of-river operations. The critical factor for protection of habitat values is maintaining adequate fresh water flow in the tributaries and the River that meets the needs of plants and animals, particularly anadromous fish.

Flood control values are provided by vegetation and permeable soils. The Hudson's marshes undoubtedly provide flood protection and should be preserved for these values. Wetlands intercept and store storm water runoff for gradual release, mitigating the effects of heavy floods (Ogawa and Male, 1983). Although most research has focused on upland as opposed to tidal river wetlands, a frequently cited example is a study in which 8400 acres of wetland along the Charles River in Massachusetts was estimated to provide $17 million in flood protection benefits per year (U.S. Army Corps of Engineers, 1972). As a result, the study concluded that it was less expensive to preserve the wetland areas than to remove them and then have to build flood control structures to compensate for lost flood control benefits.

In addition, impermeable surfaces of developed areas and runoff from deforested watersheds should be reduced through active stormwater management programs that reintroduce permeable surfaces, protect vegetated areas, and limit runoff from new development.

FURTHER READING

The best source of information on water use in the Hudson are the findings of the **Hudson River Basin Study Group (1979a,b)**. A more recent discussion of water resources and local water supply systems can be found in DEC studies on State water resources such as **Hazen and Sawyer (1987)**. For a discussion of wetland flood control mechanisms, see **Ogawa and Male (1983)**.

## 4.3 Pollutants and Water Quality

The effect of pollutants in the River ecosystem has received a great deal of attention. Pollutants can be divided into two categories: *point source pollutants* that enter the River from a specific discharge area (usually a drain pipe) and *non-point source pollutants* that enter the River over a broad area.

### *Issues and Practices*

#### *Point Source Pollution*

Point source pollution includes municipal sewage which is composed largely of organic materials and industrial wastes which can contain organic material and toxic chemicals. Municipal sewage can also contain toxic chemicals originating from industrial sources, domestic use, and the water supply system. All point sources of pollution in NYS are regulated under the State Pollution Discharge Elimination System (SPDES) permit program.

Over the period 1979-1981 there were 455 permitted dischargers releasing pollutants into the surface waters of the Hudson River Basin (Johnson and Schmidt, 1983). Included in this total number were 165 municipal sewage plants, 266 industrial plants, 12 commercial facilities, 6 institutions, and 6 private residences. Most permits were held in the lower portion of the Hudson (including tributaries) with smaller numbers in the upper Hudson and Mohawk valley. Several years later, the number of dischargers in the Hudson Basin was 550, although the difference may reflect the inclusion of Hudson River basin discharges originating in other states (Rohmann, 1985).

Sewage must be processed through at least two levels of treatment. *Primary* treatment includes removing all material that either floats or settles. *Secondary* treatment involves using bacteria to breakdown up to 85% of the organic matter (Johnson and Schmidt, 1983). Although all sewage treatment plants were to have secondary treatment by 1984, a number still do not meet this standard, primarily due to the high capital cost required to build and upgrade treatment facilities. Even in upgraded facilities, treatment of municipal sewage is hampered since sewage and stormwater are combined in the same system. In periods of heavy rain or snow melt, sewage treatment plants do not have the capacity to retain the volume of incoming effluent and are forced to let torrents of stormwater and raw sewage flow directly into the River, an event called a *combined sewer overflow* (CSO). In addition, sewage treatment plants do not alter toxins received from industrial dischargers, roadway runoff, or from paint and solvents that may be poured down a home-owner's drain. Industrial discharges that may interfere with the function of sewage treatment plants are prohibited under a State and federal industrial pretreatment program where communities must adopt standards to protect the sensitive secondary treatment process.

Although enormous gains have been made in sewage treatment and improvement in water quality, this success has been tempered by the greater threat that toxic chemical pollution presents. In an inventory of 26 toxic chemicals, 185 institutions in the Hudson River Basin held discharge permits for at least one of these compounds between 1978 and 1983 (Rohmann 1985, Rohmann and Lilienthal, 1987). Discharges are distributed throughout the Hudson River Basin (Figure 17). Many permits included more than one of the target chemicals and other substances that were not inventoried.

In another study of toxic chemical discharges, information derived from toxic chemical release reporting requirements under the Superfund Amendments of 1986 indicated that 74 companies discharged an annual combined total of over 50,000,000 pounds of toxic chemicals into the Hudson River drainage basin. The reporting requirements included only corporate facilities that had ten or more employees and that manufactured, imported, or processed more than 75,000 pounds of any of the 308 hazardous chemicals listed by the EPA within a calendar year (Barclay, 1989). Since both the federal and State regulations include self-reporting requirements where the discharger documents how much of a toxic chemical is released, estimates of the total release of these chemicals are likely to understate the actual amount released.
In addition to the continuing problem of controlling today's

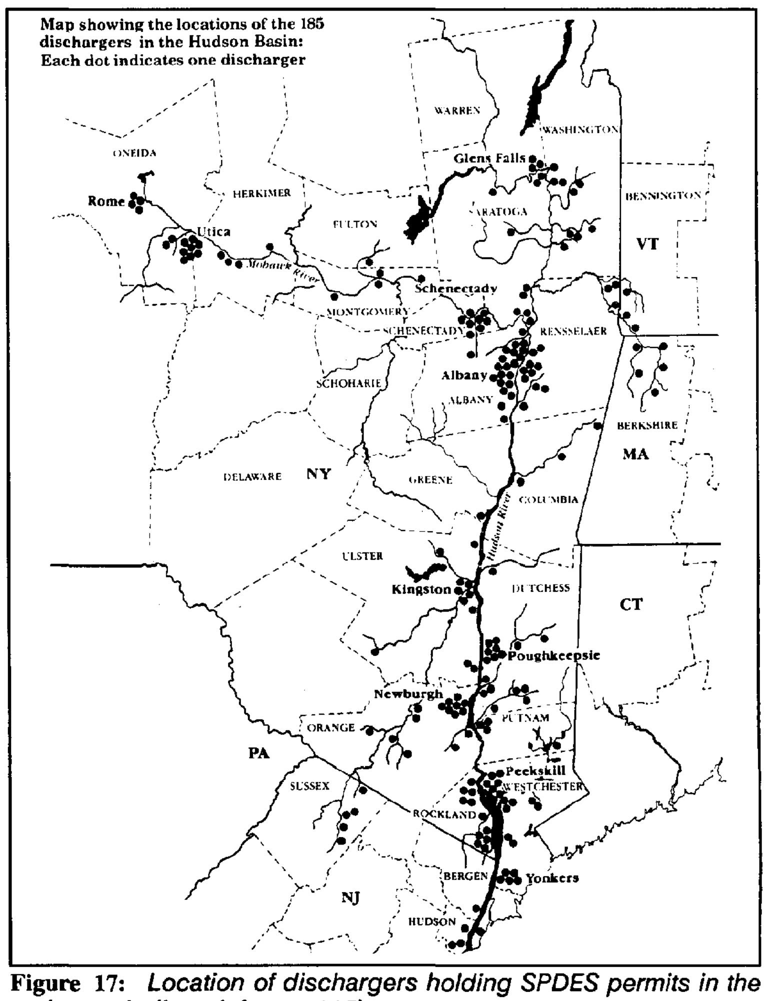



**Figure 17:** *Location of dischargers holding SPDES permits in the early 1980's (from Inform, 1985).*

discharges, yesterday's disposal practices also present problems in the Hudson River. Foundry Cove, an EPA Superfund site, is contaminated with levels of nickel and cadmium that present an immediate health hazard. Plans are well underway to reduce this contamination which resulted from a battery manufacturing plant. Another example is the large landfill on Croton Point which is leaking toxic chemicals directly into the River.

*Nonpoint Source Pollution*

Nonpoint source pollution does not result from a specific source or discrete discharge, but originates from pollutants carried into the River over broad areas. Nonpoint sources of pollution include agricultural runoff, urban runoff, atmospheric deposition, and groundwater leachate. Nonpoint source pollution is more difficult to measure or control than pollution entering from a discrete point. Nonpoint source pollution is also ubiquitous, entering the Hudson along the entire length of the estuary.

*Agricultural runoff* includes water-soluble pollutants and pollutants associated with soil erosion. Soils contain heavy metals including lead, chromium, and arsenic which are naturally present at low concentrations. Soil erosion also directly degrades water quality in the River by raising turbidity, decreasing dissolved oxygen, and elevating nutrient levels; increases sedimentation rates in marshes, shallows, flats, and deepwater communities; and eliminates spawning grounds in tributary streams. In addition to pollution that can result from soil erosion alone, agricultural runoff includes fertilizers, pesticides and herbicides. Fertilizers include nitrogen and phosphorus compounds which percolate through the soil into groundwater or wash directly into the River. Persistent pesticides are resistant to breakdown in the environment and include DDT, chlorodane, dieldrin, and endrin. These chemicals adhere tightly to soil and still enter the River ecosystem through agricultural runoff, even though their use has been banned in the United States for a number of years. Pesticides and herbicides in current use are less persistent in the environment, degrading through exposure to sunlight or bacterial decomposition. These chemicals tend to be water soluble and high concentrations can appear in agricultural runoff soon after their application.

*Urban runoff* includes pollutants associated with urban and suburban development that enter the River through direct-discharge storm sewers and direct runoff that occurs at street ends for example. Pollutants in urban runoff that are associated with roadways and paved areas include heavy metals (e.g. lead, cadmium, and chromium), inorganic chemicals (e.g. cyanide, asbestos), gasoline, and oils. Pollutants associated with residential development include fertilizers, pesticides, herbicides, which are largely used for lawn maintenance. Urban runoff results directly from perrmeable surface areas in developed areas. Streets, parking lots, roofs, and compacted soils all reduce the land's water retention capacity and lead to large volumes of pollutant-laden runoff entering the River. Since most municipalities have combined sanitary and stormwater systems, the volume of urban runoff during storms can also exceed the capacity of their sewage treatment plant, flushing raw sewage directly into the River.

Herbicides applied to railroad and highway rights of way enter the River as nonpoint pollution. Kiviat (1978) describes the railroad's herbicide application procedure of the early 1970's which involved two men on a tank car using hoses to spray the railroad embankment, creating clouds of herbicide that drifted into adjacent marshes. Even if herbicides are carefully applied, the proximity of the railroad to the water and the porous embankment gravels guarantee the entry of herbicides into the River. Significant insecticide and herbicide concentrations can also enter the River ecosystem from attempts to control undesirable species. In the past, control of the spread of exotic water chestnut plants was attempted using 2-4,D and other chemicals.

Atmospheric pollution also enters the River through precipitation and fallout, although the contribution from these sources requires further study. Groundwater that enters the River through springs and upwellings is another potential source of pollutants if it has been contaminated by landfills, chemical spills, and agricultural practices. And finally, pollutants buried in River sediment may be reintroduced into other physical and biological components of the ecosystem when disturbed by dredging and shipping or scouring by currents.

### *Impacts of Pollutants*

*Sewage*

Untreated sewage is a rich source of nutrients, including nitrogen and phosphorus, and organic matter. Under natural conditions, the productivity of plants is limited by the nutrients that are in short supply in the ecosystem. When sewage is added to the natural system, plant productivity sharply increases and organic matter is rapidly produced, usually through algal blooms. As algae and other plants die, the organic matter they produced, as well as the organic matter contained in sewage, undergoes bacterial decomposition. The dissolved oxygen content of the water can be completely depleted, resulting in the death of additional organisms. In severe cases, all the animals in the water can be killed and the once healthy tidal community becomes a dead system, with a layer of foul mud resembling black mayonnaise.

Nutrient enrichment results in a condition called *eutrophication*. The effects of eutrophication are particularly pronounced in summer; warmer water holds less dissolved oxygen, and both plant productivity and bacterial decomposition rates increase. Before sewage treatment plants were introduced, the "Albany Pool" was a festering cesspool for most of the summer, with little or no fish life. Primary treatment reduces the amount of nutrients and organic matter that enter the waterway by removing coarse matter, floating scum, and settleable particles from raw sewage. Secondary treatment further reduces organic matter using an accelerated bacterial decomposition process which reduces the amount of oxygen depletion occurring in the natural system. The process results in a treated, disinfected liquid or *effluent* which is released into the River, while leftover sludge is buried in landfills or dumped in the ocean (Congress has banned ocean dumping of sludge after 1991).

In addition to organic matter and nutrients, municipal sewage may contain heavy metals in the effluent stream; one study by the National Resource Defense Council estimated that over 4000 lbs of heavy metals pass through New York City sewage plants every day. The effluent stream can also contain harmful bacteria that escape disinfection; disinfectants which depress natural bacteria populations in the River; and, plastics that present physical hazards to fish and wildlife.

*Heavy Metals*

Heavy metals are acutely toxic to animals and to a lesser degree, plants. In humans, cadmium affects lungs and kidneys, lead affects kidneys and the nervous system, and mercury harms the nervous system, skin, lungs, and kidneys (Rohmann and Lilienthal, 1987). Heavy metals have similar harmful effects on animals, and can reduce plant growth and respiration rates (Daiber, 1986).

Under normal conditions, heavy metals are not water-soluble and either accumulate in sediments or concentrate in living organisms through *bio-accumulation* and *bio-magnification*. Bio-accumulation results from the chemical affinity of metals and other contaminants for fatty body tissues. Since heavy metals are not metabolized, the fat soluble metals accumulate at higher and higher concentrations in the animal with the consumption of each contaminated meal. Bio-magnification occurs as toxins bio-accumulated at one level of the food chain are passed on to the next level through predation. Since the predators consume prey that have already accumulated toxins from the environment, the concentration of toxins in the predators' diet is relatively higher than in their preys' diet, resulting in higher toxin concentrations in predator tissues. The level of contamination is magnified with each step up the food chain.

Heavy metals persist in the environment, and do not break down or decompose into benign compounds. Once a metal enters the food chain it is rarely lost, but cycles continuously through different trophic levels. Removal of contaminated sediments is one of the few ways to remove heavy metals from the ecosystem and can generally only be achieved through dredging. Although dredging can resuspend up to 5% of the sediments in the water column, the metals tend to remain bound to the sediment and do not necessarily enter the food chain. In the long run, the benefits of having contaminated sediments removed from the River outweigh the short term costs of dredging.

*Chemical Pollutants*

Chemical pollutants include benzene, chloroform, toluene, PCBs, and many herbicides and pesticides. These pollutants have numerous negative effects ranging from producing cancer in fish, to thinning raptor eggshells so that they break during incubation. As with heavy metals, chemical pollutants bioaccumulate and biomagnify in the food chain. Predators at the top of the food chain make good indicators of the amounts of these substances in the environment. Osprey, for example, will only breed successfully where DDT levels are low. While some of the organic compounds are relatively unstable and breakdown rapidly, others (including chlorinated hydrocarbon insecticides and PCBs) are very stable and persist in the environment for years.

Use of pesticides in the control of plant and animal pest species creates unique ecological problems, including the evolution of resistant strains of pest species. With repeated use, surviving pesticide-resistant individuals make up the entire population, and increasing amounts of chemicals are required to control the pest. Pesticides also kill beneficial species. Since beneficial species include predators that play a role in controlling pest populations, indiscriminate loss of these predators can actually lead to an increase in the population of the pest species.

In addition to contamination by pesticides, the Hudson River has extensive chemical pollution, most notably by a group of chemicals called polychlorinated hydrocarbons (PCBs), which are found in the Hudson in high concentrations. PCBs are stable compounds that resist heat and fire, qualities that have led to the use of PCBs since the 1920's in electrical capacitators, plastics, flame retardants, and adhesives. PCBs are fat-soluble, tending to accumulate in sediments and animal tissues. PCBs are also suspected carcinogens.

Most of the PCBs in the Hudson came from two General Electric capacitator plants at Fort Edward and Hudson Falls, which released over 500,000 lbs of PCBs to the River between 1946 and 1977. Although most PCBs were contained in sediments of the upper portion of the River, the removal of a dam at Fort Edward in 1973 released PCB-contaminated sediments resulting in contamination of the entire River (Limburgh, 1985).

General Electric agreed to stop releasing PCBs in 1977 and provided $3 million for monitoring and cleanup activities. Over the past 10 years, however, there has been extensive debate over what to do about PCB contamination and little action. One approach calls for dredging the upper portion of the River to remove highly contaminated sediments that contribute to PCB levels in lower parts of the River. Another approach would allow PCBs to remain in the River to be naturally buried or even slowly degraded and that the dredging would only disturb this process. Two administrative hearings (by DEC Administrative Law Judges and Hazardous Waste Facility Siting Boards) regarding the proposed clean-up project concluded that there is a compelling public need for the dredging project and that leaving the PCBs in place was not acceptable. More recently, DEC and EPA have reconsidered the possibility of designating a substantial portion of the River as a superfund site. Meanwhile, the entire upper portion of the River between Troy and Fort Edward is closed to fishing and within the estuary, the Department of Health has recommended severe restrictions on fish consumption. Estimates indicate that fishing restrictions resulting from PCB contamination cost the State between $17 and $25 million annually in recreational fishing income and $2 million annually in commercial fishing revenue (Barclay, 1989).

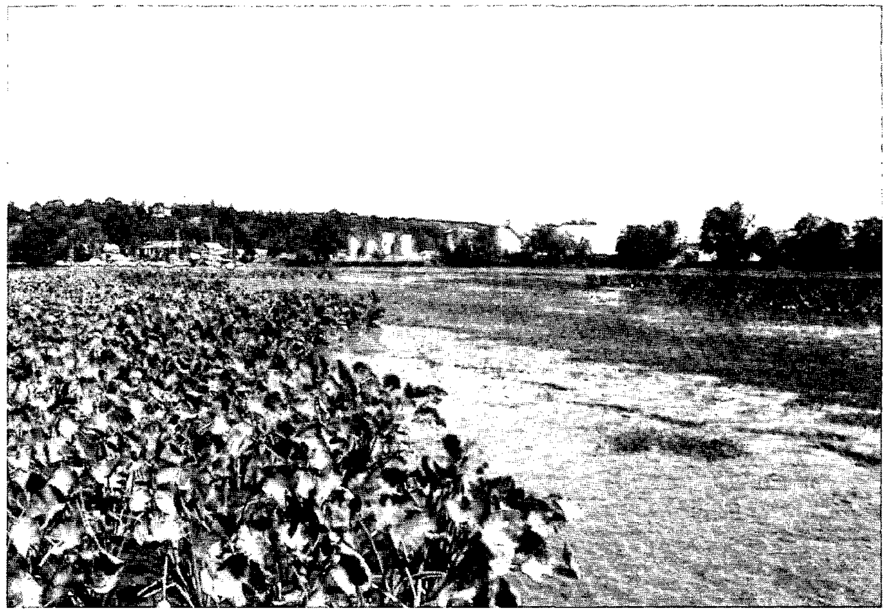


**Figure 18:** *Oil tank farms are often located adjacent to valuable habitat (N. Salafsky/TNC).*

*Oil and other Petroleum Products*
Oil, grease, and other petroleum products are among the most ubiquitous pollutants found in the River, coming from industrial discharges, leaking storage tanks, oil spills, and highway and urban runoff (Figure 18). Oil affects the biotic community by inhibiting germination of plant seedlings, destroying plant leaves and shoots, and killing birds and fish (Daiber, 1986). The tendency of oil to float on water makes it particularly disruptive to the mudflat and shore habitats, where most of the sensitive biological activity is concentrated on the surface of the sediment. Oil is also toxic to insect larvae and zooplankton that use the water surface; before the development of synthetic pesticides, oil was often directly applied to marsh areas to control mosquito populations.

*Other Pollutants (Salt, Paint, Debris, Radioactivity)*
In addition to the toxic pollutants discussed above, there are many other pollutants that adversely impact the River. A large amount of salt is added to the River from highway and urban runoff and snow disposal. Salt could have an effect on spawning fish and their larvae which may be sensitive to fluxes in salinity. Salt stored in piles for use in de-icing also contain anti-caking compounds that often contain arsenic. Toxic compounds can also enter the River from construction and maintenance activities. An example is lead pollution that results from paint flakes that fall into the River during bridge maintenance. The solid waste disposal crisis has led to reports of waste disposal in the River, including demolition debris, tires and food containers. Litter can also directly impact wildlife, an example is the plastic 6-pack ring that can choke birds and other animals. Radioactive contamination from atmospheric fallout and nuclear power plants must also be considered. Radioactivity can disrupt many aspects of the ecosystem and should be carefully controlled.

*Wetlands as Natural Sewage Treatment Systems*
Since wetlands can act as sinks for nutrients and chemicals, they could also be managed to remove wastes added to the River system by humans (Hammer and Kaldec, 1983; U.S. EPA, 1983). Managed wetlands are envisioned as solar powered sewage plants (Odum, 1978). The properties of wetlands supporting this view include anoxic sediments that retain chemicals, sedimentation rates that bury pollutants, and plant and bacterial processes that can remove nutrients (Daiber, 1986). Studies conducted on waste treatment by wetlands have concluded that freshwater marshes can assimilate limited amounts of nitrogen from sewage while increasing the oxygen content, although these benefits are seasonal in nature and do not work well for toxic wastes (Whigham and Simpson, 1976; Kaldec, 1978; Daiber, 1986).

***Habitat Protection Measures***

The only effective way to reduce impacts of pollution on River habitats is to eliminate or minimize introduction of these substances into the system. The SPDES program is designed to control and monitor all major point sources of pollution. Compliance with this program is largely the responsibility of the permittee who must monitor and report the amounts and types of substances being released into the water. DEC staff make periodic inspections of facilities and take water quality readings, but they do not have the resources to monitor compliance with permit restrictions systematically, so that many violations may go undetected and unreported. The detrimental effects of point source pollution can also be reduced by ensuring that treated effluent and industrial wastes are not released in the most biologically valuable portions of the River. Containment structures designed to prevent leakage or spills from oil and gas storage tanks should also be regularly inspected and maintained.

There is no single program analogous to SPDES that addresses nonpoint source pollution. Numerous steps can be taken to reduce the effects of urban and agricultural runoff on the Hudson River habitats. Municipalities which are upgrading their existing water delivery and treatment facilities can enhance the efficiency and effectiveness of both by constructing separate systems for collection and treatment of sewage waste and stormwater runoff. Municipalities can also expand current programs that collect and safely dispose of or recycle household chemicals, paints, automotive oil, and batteries that otherwise may lead to contamination. Local soil conservation offices and other agencies can recommend best management practices to minimize runoff and soil erosion. Application of insecticides and herbicides can be replaced with biological control methods or their use can be limited to selective applications timed to coincide with pest outbreaks rather than routinely scheduled spraying.

Salt storage runoff impacts can be reduced by using covered storage facilities. Highway and railroad rights-of-way can be maintained through mechanical removal of vegetation in sensitive areas instead of herbicides. It may be cost effective to plant shrubs or perennial ground-covers that would eliminate the need for vegetation maintenance (Kiviat, 1978). Highway and bridge repair work should avoid introducing lead-containing paint scrapings and other pollutants into the River ecosystem.

FURTHER READING

The best source on toxic pollutants in the Hudson is the Inform study published in two volumes: **Rohmann (1985)** and **Rohmann and Lilienthal (1987)**. These contain detailed maps and information for 26 major toxic pollutants. **Johnson and Schmidt (1983)** explains the SPDES system and also describes specific dischargers. For a history and technical discussion of PCBs in the River, see **Limburg (1985)**.

## 4.4 Transportation

The Hudson River serves as an important transportation corridor for the movement of goods and people in one of the most densely populated regions of the country. Transportation has significantly impacted the tidal habitats.

### Freight and Passenger Traffic

Transportation routes using the Hudson Valley are both waterborne and land based; currently most of the freight traffic is waterborne while passenger traffic is land based.

***Issues and Practices***

*Freight Traffic*

Since the middle of this century, Albany has served as a deep-water port, handling freight traffic from ocean-going ships, barges, and a variety of smaller craft. Access to the port by larger vessels is facilitated by maintenance dredging in the River channel. Waterborne traffic along the River consists largely of petroleum products, raw materials, and some finished goods. Although the overall tonnage shipped had declined since the mid 20th century, there was a resurgence of shipping in the 1980's based on the regional distribution of bananas and Volkswagons. More recently, the Port of Albany has lost a significant portion of its business to modernized ports. Freight is also hauled in the Hudson Valley on the railroads that flank the River shore and on the nearby Thruway.

*Passenger Traffic*

In the early nineteenth century almost all travellers in the Hudson Valley boarded sloops and steamships. Since the mid-nineteenth century, passenger traffic has been largely land based, and continues today with extensive ridership on the Amtrak lines along the Hudson and the Thruway between New York and Albany. Reminders of older means of travel do exist; the Day Line still operates limited ferry service from New York City to points along the River, and the Clearwater, a replica of the Hudson River sloops, plies the waters of the estuary.

***Impact of Transportation***

*Waterborne Traffic*

Since the Half Moon first ran aground on a mudflat in 1609, the different kinds of transportation used over the years have had an enormous impact on the River eco-system. While earlier use of canoes and sailboats had only affected the riverbank at docking areas, the advent of steam power coincided with a greater ability to pollute the River. Initially pollutants were largely limited to ash and cinders that can still be seen in sediments along the shore. More recently, petroleum products have polluted the River, from both engines and cargoes of ships. For example, over 420,000 gallons of oil spilled into the River in 1977 when the barge *Ethel H* struck Con Hook Rock, resulting in an oil slick reaching Long Island (Hall, 1978).

Large cargo ships also impact shallow water and shore communities (Figure 19). Large ships create a drawdown in water levels as they displace water from the shipping channel, alternately flooding and exposing shore and flats through wildly oscillating water levels and large wakes which scour sediments and cause local rises in turbidity. Wakes may have their greatest impact in early spring when vegetation has not established a protective cover, newly-sprouted plants are vulnerable to being washed away, and young fish are more susceptible to water elevation fluctuations and increased turbidity.

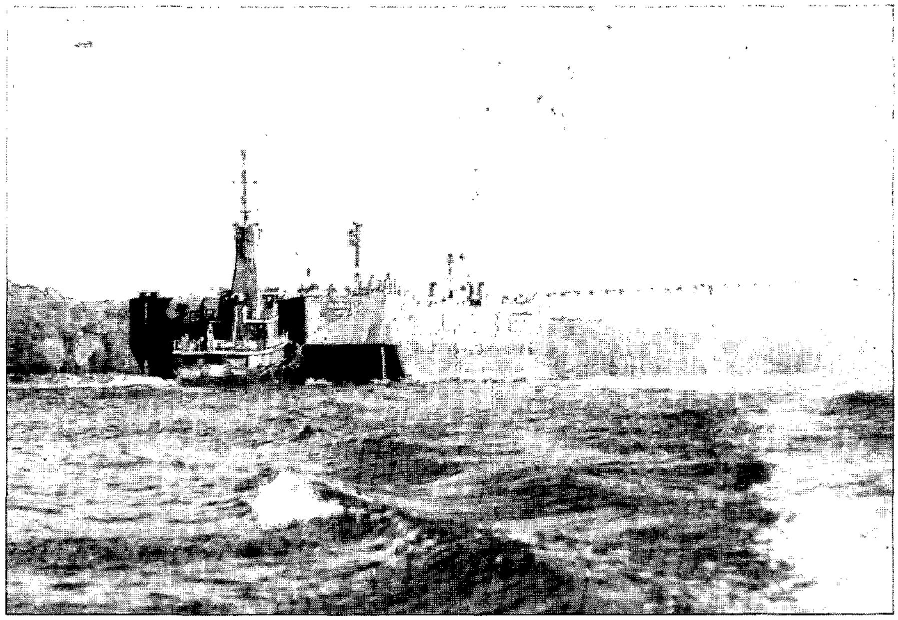


**Figure 19:** *Tugboat and barge near The Flats above Kingston (N. Salafsky/TNC)*

Large ships also impact deepwater communities, although this may be limited to the channels where the vessel propellers resuspend sediments as they pass several feet above the River bottom. Large ships also discharge ballast water that comes from the port of origin. Although not documented for the Hudson River, ships of the same class as those used on the Hudson have introduced exotic species that have become pests in the Great Lakes. Overall, the combination of dredging required to facilitate ship passage and the use of large cargo ships in the River has had adverse impacts on the River ecosystem.

*Landbased Traffic*

Land based transportation modes have had as much of an impact on the River as did waterbased modes. Foremost among these impacts was construction of the railroad lines along both banks of the River which, at the expense of much shore community, created many coves where marsh and shallows are now found. Currently, a significant impact results from herbicides applied along the railroad right-of-way which, in addition to having localized effects on sensitive plant species, introduces toxic chemicals into the environment. Other effects of the railroad include disturbance of wildlife by trains rushing through the habitats, possible sewage discharges along the tracks, and the potential for spills from a derailment.

Highways in the Hudson Valley also can have significant impacts on the River. Pollutants including lead, oil, and salt, drain into the River in significant quantities from highway runoff. Paint and other materials used to maintain bridges over the River and its tributaries are a potential source of toxic contamination.

***Habitat Protection Measures***

The River's water quality will continue to improve as maintenance protocols designed to prevent hydrocarbon leaks from both engines and cargoes are strictly implemented and enforced. Contingency plans for cleaning up major oil spills exist; it may be appropriate to review and update these plans so that they include the latest information regarding sensitive habitats and organisms. Without reducing river traffic, there is no obvious solution to the impacts of large boat wakes on the tidal habitats; however, barge-based shipping would have less impact both in decreasing the amount of water level fluctuation and in reducing the need for maintenance dredging. Port marketing efforts should be directed at barge traffic rather than large vessel shipping to lessen the impact of shipping on the River's habitats.

FURTHER READING

Historical information concerning transportation along the River can be found in **Mylod (1969)**. Impacts of the railroad and potential solutions are more fully explored in **Kiviat (1978)**. Recent information on commercial shipping activities on the River is available in annual reports prepared by the Port of Albany.

## Dredging and Dredge Material Disposal

Dredging involves sediment removal from the River bottom and excavation of contiguous upland areas. The resulting material is transferred to another location by barge, truck, or pipeline depending on the method of dredging used. Dredging can be done to facilitate deep draft shipping but can also be used to remove pollutant-contaminated sediments, create marinas and docking facilities, or as a source of raw materials in construction projects. Dredging has had a profound impact in shaping the Hudson as it exists today and is necessary for the continued use of the River as an economic resource.

### *Issues and Practices*

*History of Dredging on the Hudson*
The Hudson River's navigation channel is maintained by the Department of the Army, Corps of Engineers New York District (Corps). The Corps is authorized by Congress under the Rivers and Harbors Act to "provide waterborne access to the Port of Albany, and to the New York State Barge Canal System to the north and west of Albany" (most information in this section is based on MPI, 1983; and US Army Corps, 1988).

Dredging the Hudson River began in 1900 in New York City, south of the present day location of the George Washington bridge, and was extended 11 miles upriver between 1917 and 1937 (MPI, 1983). Between 1926 and 1930, a 27 foot deep channel was dredged between Hudson and Albany, and from 1931 to 1954 the channel south of Hudson was also dredged to a depth of 27 feet. Between 1954 and 1966, the entire channel from Manhattan to Albany was dredged to its present depth of 32 feet. In addition to the main channel, six auxiliary channels were dredged including Catskill Creek, Saugerties Harbor, Rondout Harbor, Wappinger Creek, Peekskill Harbor, and Tarrytown Harbor. The Corps is currently conducting a study to evaluate providing access for larger vessels on the Hudson, either by deepening the entire channel or by creating deepwater areas in which ships could anchor during low tide.

*Maintenance dredging* is required to remove sediment accumulations in the channel; the most recent maintenance was performed in 1988. In addition to channel dredging, the Corps has also conducted snagging and clearing operations to remove downed trees and other debris that impedes navigation. Due to the variation in depth and sedimentation rates, more dredging is required in some parts of the Hudson than others. Most maintenance dredging has occurred in two sections of the River: between Nyack and Peekskill; and, from Kingston to the dam at Troy. The River's natural depth precludes the need for dredging between these areas.

Historically, several dredge material disposal methods have been used. Before the mid-1970's, economic factors dictated which disposal method was used with little or no regard for the ecological impacts. Spoil was used to fill wetlands to create developable land, create new islands or enlarge existing islands in shallow areas of the River (Figure 20), or was placed in non-channel or deep channel areas of the River (MPI, 1983). Since the 1970's, natural resource protection has been a requirement in planning dredging operations. This is clearly reflected in Corps documents; early dredging plans (e.g. U.S Army Corps of Engineers 1965) were concerned with cost efficiency and economic development, current plans (e.g. US Army Corps 1988) assess environmental impacts and attempt to select the least damaging alternative.

*Techniques for Dredging and Dredge Spoil Deposition*
Dredging is conducted either by hydraulic pump or mechanical removal by several diffferent techniques, each having advantages and disadvantages (MPI, 1983). The preferred dredging technique depends on the disposal method used, the nature of the sediments being dredged, the potential ecological impacts on the surrounding areas and the types of equipment available.

Several methods of dredge material disposal are available, each having associated costs and benefits. Factors in selecting a disposal method are the high economic cost of transporting dredged materials to a disposal site and the local ecological impacts. Adjacent upland disposal has relatively low transportation cost, but suitable sites located near a dredging operation are difficult to obtain.

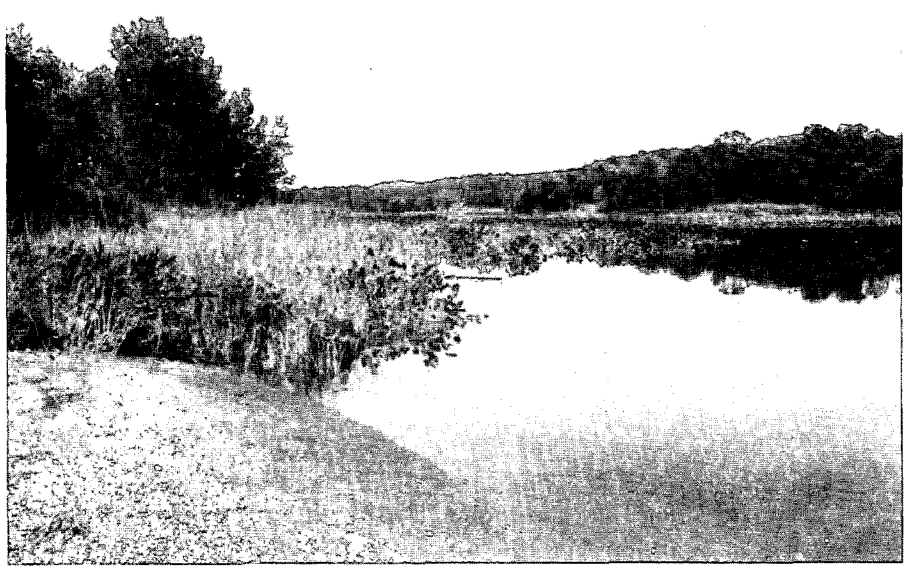


**Figure 20:** *Dredge fill encroachment into wetlands at Roeliff-Jansen Kill (N. Salafsky/TNC).*

The cost of a recent dredging operation was increased by over a million dollars solely due to dredge material disposal costs; lacking a suitable upland site, the dredged material had to be barged to the ocean. A study of dredging the Hudson concluded that upland disposal, beach nourishment, and wetland creation are the preferred disposal alternatives for clean material and that contained upland disposal is the best method for sediment contaminated by PCBs and other toxic pollutants (MPI, 1983). More recently, the use of subaqueous borrow pits for the disposal of contaminated sediments has been considered, although these sediments are relatively rare in the River's navigation channel (US Army Corps, 1988).

Dredging should be conducted in a manner that minimizes the need for repeated maintenance and to prevent re-entry of materials to the River channel. Most Hudson River dredging is subcontracted by the Corps to private firms. The Corps conducts inspections to ensure that dredging and disposal activities are carried out properly; careless work can lead to more frequent dredging and results in needless environmental damage and cost (Darnell, 1978).

### *Impacts of Dredging*

*Direct Impacts*
Dredging can eliminate tidal communities through direct removal of the site. Direct adverse impacts from dredging involve the loss of the uppermost sediment layer in which most benthic organisms live and many swimming organisms feed. Maintenance dredging of the main navigation channel would probably not eliminate ecological values that could not be regenerated since the channel has previously been dredged. Direct adverse impacts are associated with proposals that would deepen the channel or create deep anchoring areas through removal of deepwater, shallows, or mudflat communities. Dredging in the six auxiliary channels may have adverse impacts depending on the changes in these areas that have occurred since the last dredging operation and the likely development pressures on adjacent ecological communities that would result due to improved navigability. Waterfront development may result in removal of ecologically valuable areas through private dredging operations conducted on smaller tributaries or backwater areas of the River. Dredging proposals involving adverse impacts have increased along with the demand for recreational boat facilities.

*Indirect Impacts*
The impact of maintenance dredging on adjacent areas may be of greater concern than direct impact on the dredged area. Indirect impacts fall into three categories: immediate impacts associated with dredging; impacts from disposal of dredge material, and long term impacts on the River ecosystem.

Dredging can create a local turbidity plume which adds to the suspended sediment load. Suspended sediment can reduce the oxygen content of the water, interfere with fish respiration, and limit photosynthesis. This effect is pronounced with sediments that have a high organic content, while turbidity plume impacts are negligible with sandy sediments. In general, suspended sediments from a typical dredge plume are tolerated by fish (MPI, 1983). In practice, fish can also swim away from most localized dredging. When contaminated sediments are involved, however, damage to fish populations can result if contaminants are reintroduced to the food chain. Special dredging techniques that reduce the turbidity plume may be necessary to avoid this impact.

*Dredge Material Disposal*
The practice of disposing material without regard to the ecological value of the River communities had the greatest impact on the River due to dredging. Today, it is not likely that material will be disposed of within the River. Several potential beneficial uses of dredge spoil are exceptions to this generalization. Sandy dredge material can be used for beach nourishment which provides one of the few effective means of counteracting the effects of shoreline erosion. Sandy sediments can also be used as construction material with a market value that warrants the establishment of reusable disposal sites where the material is trucked away for beneficial use at no public cost.

The use of dredge material for the creation of wetlands has also generated considerable interest. The Corps has identified at least 22 sites on the Hudson that may be suitable wetland creation sites. Wetland or marsh creation on the Hudson is a practical alternative and is not as complicated as creating non-tidal freshwater wetlands where artificial control of water levels is usually required. Any wetland creation scheme would likely involve sacrificing an existing ecological community (such as flats or shallows where material would be deposited) and may not be desirable until mitigation techniques have been proven to work effectively under local conditions and only after conducting an evaluation which concludes that the value of the new wetland community would be greater than the displaced community. This conclusion could be reached in areas of the River where wetlands are not already abundant. Since the restoration of Foundry Cove, an EPA superfund site, includes replanting a native marsh after the contaminated sediments are removed, the techniques for marsh creation on the Hudson River should be well-documented and tested in the near future.

A further potential adverse impact of dredge material disposal is associated with transportion to suitable disposal sites, usually when hydraulic pipe systems are used. Damage can result from pipe leaks in ecologically important areas and from building access roads needed for laying pipe between dredging and disposal sites. Under current plans, temporary roads will be employed if necessary, using low quality wetlands that are dominated by common reed or loosestrife when possible (MPI, 1983). Although temporary roads that can be removed after work is completed have significantly reduced impacts when compared to the past practice of permanent road construction, even wetlands that have been designated low quality do provide important values and will require restoration or enhancement.

*Long-Term Effects of Dredging*
Long-term effects of dredging on the River ecosystem are difficult to assess. The Hudson has undergone more than 350 years of human development and many if not all of the existing significant habitats have been affected. Nonetheless, it is desirable to avoid adverse impacts on existing habitats whenever possible. The largest impacts of dredging are probably altered hydrology, sedimentation, and geography of the River. Effects on the River's geography have persisted long after the dredging has been conducted; this is particularly evident in the number of islands in the River that are now connected to and indiscernible from upland, curiously keeping their island names. Many of these islands and disposal sites were bulkheaded to contain sediments and prevent their re-entry to the River; these bulkheads are failing in many areas (Figure 21). Dredging has undoubtably altered the River's hydrology by increasing tidal flow with the elimination of constriction points in the natural River channel. The effects of this change in hydrology on tidal amplitude, currents, and salt front movement have not been investigated. Sedimentation in the River has increased with the deforestation and development of the watershed. Since dredging is normally required in areas that naturally accumulate sediments, dredging may have beneficial effects through the removal of this excess material.

***Habitat Protection Measures***
Adverse impacts on fish and other aquatic species from dredging can be minimized by conducting dredging during the late summer and fall when the sensitive period of reproductive activity is largely completed.

On the Hudson River, significant adverse impacts on the tidal habitats are not likely to occur under current plans for maintenance dredging of the Federal shipping channel. Deepening the channel to increase commercial shipping by providing access for larger draft vessels, as called for in a proposed plan, has the potential to severely affect significant habitats in the River and its tributaries which probably could not be avoided or mitigated. Rather than pursuing a deeper channel to attract larger vessels to the Port of Albany, an alternative approach would focus marketing efforts and facility design on shallower draft vessels. Since less than three percent of commercial River traffic in 1977 had a draft of greater than 18 feet, it may be worth comparing the economic and environmental costs of dredging required for deep draft vessels with their contribution to the regional economy. The amount of maintenance dredging and impacts on the River would be reduced if the channel depth could be maintained at less than the current 32 foot depth. Calculating the true economic costs of dredging and its associated environmental impacts might prove expansion of the channel or even maintenance at current levels to be financially unsound, particularly if an economic niche relying on shallow draft coastal vessels could be developed for the Port of Albany.

FURTHER READING
Most of the information on dredging is derived from an environmental impact statement on dredging in the Hudson River produced for the Corps by **MPI (1983)**. Additional details can be found in subsequent reports such as **U.S. Army Corps (1988)**.

## 4.5 Shoreline Development

Much of the shoreline along the Hudson River and its tributaries has been altered through the construction of bulkheads, revetments, and dikes. These structures have had a profound impact on the distribution and composition of the River's significant tidal habitats.

### Diking and Development
Tidal areas have historically been destroyed directly through diking and filling for agricultural, industrial, and residential development and indirectly by embankments for railroad lines or for containing dredged materials. Direct bulkheading and diking tends to convert an area permanently to upland, whereas indirect destruction retains elements of the original wetland (Daiber, 1986).

***Issues and Practices***

*Creation of Fast Land*
Fast land, or upland, is created when an area is diked and then filled. A great deal of the River has been filled near urban areas where the demand for waterfront land has been the greatest. Filled land has been used for parks, housing, and industries. Land creation can also occur through passive processes. Maps of the upper portion of the estuary from the 1800's and the present, reveal that much of what is now mainland shore was once shallow backwater or naturally occurring islands (Figure 22). Although land was directly created using dredge material, sedimentation has appparently also accounted for land creation, particularly behind bulkheads that may have been built as breakwaters. These newly created lands were often used for agricultural purposes.

*Railroad Coves*
Many coves along the Hudson's shoreline were diked when the railroads were constructed. Other coves were diked to grow rice and for waterfowl management.

Although the railroad tracks generally followed the River's shoreline, tracks were laid directly across coves on fill embankments in order to provide the straightest track alignment (Figure 23). In coves where a tributary stream flowed into the diked area, culverts were placed under the tracks to reduce hydrostatic pressure by allowing flow to the River. Tidal flow was also facilitated through culverts. Depending on the size of the cove, the amount of freshwater inflow, and the tidal amplitude, connections ranged from small culverts to large open channels, which were bridged by the railroad.

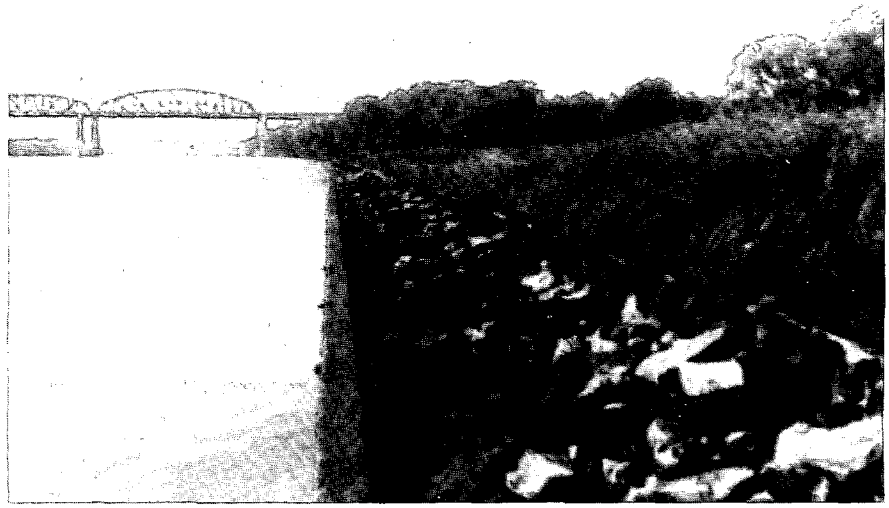


**Figure 21:** *Bulkhead retaining dredge material at Shad and Schermerhorn Islands (N. Salafsky/TNC)*

### *Impacts of Dikes and Shoreline Development*

*Habitat Destruction and Buffer Zone Development*

Diking and fast land creation directly destroys valuable tidal habitat. Human activity on the Hudson River has permanently destroyed large amounts of marsh, flats, and shallows. Shoreline development also threatens tidal habitats indirectly. For example, adjacent upland areas are ecologically linked to the tidal habitats by proximity, watershed, and soil characteristics. Development of these *buffer zones* can change the amount and nature of freshwater inflow, water quality, sedimentation rates, water level fluctuation, and species composition. Development in the buffer zone can also alter the suitability of adjacent habitat for plants and animals that are unable to tolerate human disturbance; examples are heart leaf plantain which is subjected to trampling, and bald eagles that require undisturbed areas for roosting and nesting.

Bulkheads also compound the effect of wakes and waves. Natural shoreline absorbs wave energy as waves run up a beach or rocky shore, or in the case of larger waves, through erosion, which dissipates energy through removal of shore material. Rather than losing their energy, waves rebound off hard bulkhead surfaces and scour the area in front of the bulkhead, eliminating beach, marsh, and mudflat. Bulkheading also prevents ecological

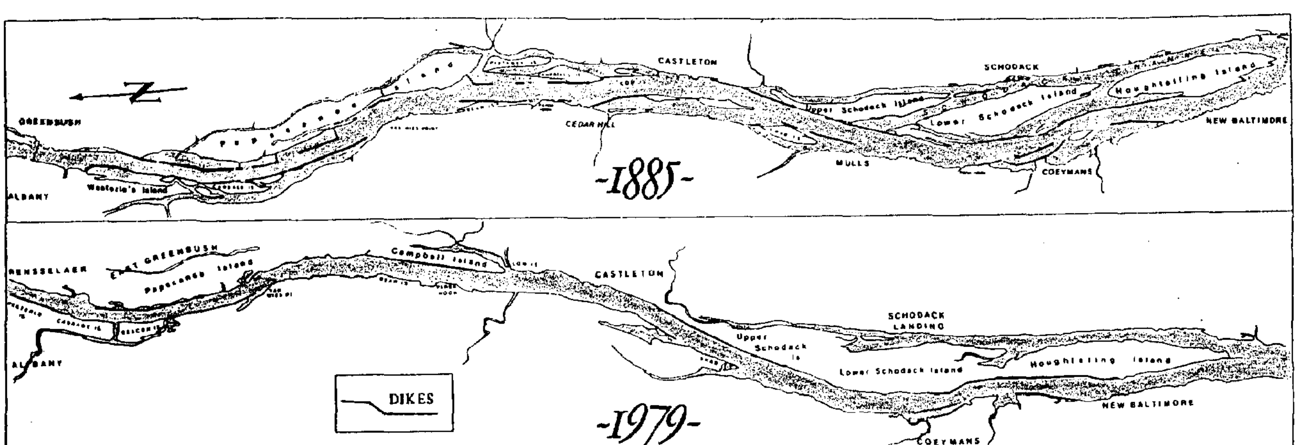



**Figure 22:** *The effects of diking and disposal on the Hudson River shoreline between Albany and New Baltimore (from Clearwater, 1979).*

**Figure 23:** *Railroad tracks fronting cove at Stockport (N. Salafsky).*

communities from evolving through natural succession or in response to events such as sea level rise (section 3.4).

*Reduced Water Circulation*
The impacts that resulted from the creation of the railroad coves are difficult to evaluate. Railroad embankments have generally reduced water circulation. Although water levels still rise and fall, the flushing action of the tides is reduced and sediments tend to accumulate. Furthermore, the linkage between cove marshes and the main body of the River is impaired, with reduced exchange of detritus and nutrients. Marshes that are landward of the railroad tracks are also more prone to invasion by species such as purple loosestrife and common reed (Bob Zaremba, pers. comm.). Impounded areas are generally less productive and have lower species diversity than naturally occurring areas, although certain species may be found in greater densities in the enclosed areas (Daiber, 1986).

Despite the negative impacts associated with railroad embankments, the net impact may be positive. Many of the cove marshes may exist because of the shelter provided by the railroad embankment from River currents, waves, and scouring by ice floes. Without the railroad, marsh areas in these coves might have been much smaller or even non-existent.

The impact of the coves can be explored to some extent by comparing the east (with railroad) and west (without railroad) shores of the River. Between Albany and Saugerties where there are few coves and many sheltered points and backwaters, the distribution of marshes appears to be roughly equal between both sides of the River, with the railroad often dividing those on the east shore. South of Saugerties, where there is little natural indentation in the River's shoreline, marshes tend to be located in railroad-sheltered coves. Although not conclusive, the railroad may have resulted in the creation of a significant amount of marsh in the southern portion of the estuary, and a decrease in quality of marshes in the northern part of the estuary. From a different perspective, the impact of the railroad is unquestionably positive. Without the railroad and its restriction of access to the shore, many of the marshes would have been destroyed through riverfront development and associated fill.

Future management efforts should reflect the unique environmental conditions created by the railroad coves. Reduced circulation and increased sedimentation rates caused by the railroad are likely to lead to increased senescence of marsh communities. Many of the cove marshes could be transformed into swamp forest over time without the formation of new marsh to replace it. Marsh that has formed behind bulkheads at other points along the River shore may also be subject to a similar process.

***Habitat Protection Measures***
Direct destruction of the River's ecological communities has been significantly reduced through recognition of their values and legislation. Proposals to fill in portions of the River continue to be made for various purposes, and these proposals should be rejected. Under current law, it is difficult to obtain permits to place fill in the River for any purpose. Passive filling of the River currently requires study and management directed at sources of sedimentation and former breakwaters and man-made structures.

In addition to limiting direct impacts, maintaining undisturbed upland buffer zones may be essential to protection of tidal habitats. Different types of development can have various impacts on adjacent areas and should be evaluated for impacts that may affect adjacent, yet ecologically-linked areas. Current wetland protection laws do not include adequate buffer zones that are necessary for protection of the River's tidal habitats. Undeveloped areas of the River that do not currently support significant habitats may be required for future habitat sites, since today's significant areas are not static and will require space to accommodate their dynamic nature. Loss of these important areas can be reduced if shoreline developments are clustered in or near existing population centers or previously disturbed sites, and if adequate setbacks from the River are used.

Railroad cove marshes may be improved with enhanced flow resulting from construction of larger replacement culverts or bridges and improving flow in existing channels. Increased flow may reduce sedimentation rates, slow community succession, and delay the transformation of marsh to a swamp community (Kiviat, 1978).

FURTHER READING
See **Kiviat, (1978)** for an excellent discussion of management steps that can be taken in the coves and along the shore.

## Recreational Access

Public access to the Hudson River shoreline for different types of recreation activities is one of the most important management issues. This problem is especially acute on the Hudson River since approximately 3/4 of the shoreline is blocked to most recreational access by the railroad.

### *Issues and Practices*

*Marinas and Boat Launches*
Boating access to the River is available either at launch sites where the boat is carried to the River on a car top or trailer, or at marinas where the boat is kept for the season. The current high demand for both marina slips and boat launches is expected to outstrip available supply over the next few decades. In general, a boat launch site is fairly simple involving a boat ramp, a parking lot and access road for cars, and sufficient water depth near the ramp. A marina is much more elaborate, and can involve many slips for mooring boats, a septic pump-out station, large dock facilities, hoists for removing or launching boats, a fuel station, a boat repair area, on-land winter storage areas for boats, a restaurant and sales facility, locker and rest rooms, and a peripheral security fence. Many marinas are designed to accommodate large, deep draft boats which cannot be launched by trailer and typically include dredging and bulkheading.

Both marinas and boat launch ramps are best located in sheltered areas of the River that are protected from storms, waves, and winds. For this reason, many facilities are located at the mouth of or on a tributary. Siting additional marinas or boat launches is restricted by limited access to both tributaries and the River. The main restriction is caused by the railroad which can only be safely crossed by *grade-separated crossings* in which the roadway either goes under or is elevated above the railroad track. The railroad further limits access to the River by limiting the size of boats that can pass under the bridges at the mouths of tributary streams. Access restrictions are also created by the extent of private ownership of land bordering the River which includes many large estates. Finally, many existing facilities are exclusive. Of the 82 boat launch and marina sites located on the Hudson, only 17 are publicly owned while an additional 44 commercial sites are open to the public on a limited basis (Hudson River Access Forum, 1988).

*Swimming, Hiking, and Bicycling*
There has been a renewed demand in recent years for access to the River for swimming and hiking or biking along the shore, largely as a result of water quality improvements. Although there are only a few beaches along the tidal portion of the River where swimming is permitted, the potential demand for the use of these sites is enormous; surveys of American recreation activities indicate that over 50% of all Americans annually engage in swimming (Hudson River Access Forum, 1988). Likewise, there is extensive demand for hiking and biking trails that follow scenic paths along the River.

As with recreational boating, a major problem is finding suitable access sites for these activities. Similar problems are encountered with the need for grade-separated railroad crossings and publicly-owned sites.

### *Impacts of Recreation*

*Powerboats*
Powerboats have numerous detrimental impacts on tidal habitats, including discharge of pollutants that degrade water quality. Toxic hydrocarbon emissions, including olefins, aromatics, and paraffins, are ten times higher on average in a two-cycle engine (used by many pleasure boats) than in a comparably sized four-cycle engine (U.S. EPA, 1974 *in* Gorski, 1988). Many motor boats also use leaded fuel which introduces significant amounts of lead into the River.

Use of powerboats is also associated with fecal contamination of the water. Several scientific studies (e.g. Fisher et al., 1987) have demonstrated that increased power boat use is accompanied by increased fecal coliform bacteria counts that are associated with the presence of pathogenic bacteria. This problem can become severe in marinas with heavy boat traffic and bilge pumping combined with restricted water circulation in marina basins. The lack of pumpout facilities and the general failure to use existing facilities to properly dispose of on board sewage further exacerbates the problem. Litter is also a problem associated with recreational boating; one study of pleasure boat users found that on average, each boat trip produced one pound of litter thrown overboard per passenger in the boat (National Academy of Sciences *in* Barclay, 1989). Powerboats can also create excessive noise and large wakes that disturb various species, resuspend bottom sediments, and contribute to shoreline erosion. Minimum vessel speeds designed to minimize wakes are not particularly helpful since maximum wakes tend to form at only six to seven mph (Zabawa and Ostrum, 1980). Finally, powerboats cruising over shallows and flats, and even through marshes, directly reduce the habitat value of these areas by churning bottom sediments, increasing turbidity, damaging vegetation, and disturbing the nursery grounds of young fish and the feeding grounds of waterfowl.

*Marinas and Launch Ramps*
Marinas and, to a lesser degree, boat launch ramps can also impact the tidal habitats. Marinas and boat launch ramps require protected areas of the River. In many instances, the protected nature of an area is the same feature that has led to the formation of ecologically valuable communities. Siting requirements for marinas frequently lead to direct conflict with resource protection. This conflict is exacerbated when marina development requires extensive dredging and bulkheading that can reduce or destroy the ecological value of an area. Even under circumstances that allow for a sensitive marina design that preserves the value of an area, operation of the marina may degrade the habitat values. Boat traffic going to and from launch and marina areas can create an impact zone that fans away from the marina or launch. The magnitude of adverse impact within this zone is a direct function of vessel traffic volume and water depth. Construction of upland parking and service areas for both marinas and boat ramps can also reduce the value of buffer zones that may provide protection for the habitat.

Marinas and boat launch ramps can also facilitate the entry of toxic substances into the River. Fueling facilities can lead to spills during refueling or from storage tank leaks. Boat cleaning can result in oil, grease, bilge contents, and solvent discharges. Boat launch ramps rarely include designs to control stormwater runoff and frequently provide a direct entry point for runoff from long stretches of roadway with all of its attendant non-point source pollutants.

***Habitat Protection Measures***
Launched boats are smaller on average and less impact results from their operation than from larger boats which operate from marinas. In addition, marinas require the same sheltered environment which can also support significant tidal habitats. Resulting impacts can be minimized by clustering marinas at previously developed sites and near existing marinas. Ideal spots for marina and boat ramp construction include abandoned industrial sites and previously bulkheaded shoreline with adjacent deep water. Protected marina basins can be constructed through excavation of adjacent upland at appropriate sites to reduce impacts and construction costs by using land-based equipment.

Sites that are inappropriate for marina development include areas with previously undisturbed shoreline, creeks with significant spawning or nursery grounds for anadromous fish, areas without adequate natural water depth that would require extensive dredging of the River bottom, areas that would result in boating traffic impacts on shallows, flats, and marshes, and areas that do not have sufficient upland to support marina activities. Boat launch impacts can be reduced by following similar siting guidelines and using designs that include runoff controls.

The least disruptive way in which humans can enjoy the River and its tidal habitats is through the use of small boats (trailer or car top carried boats) and by hiking or bicycling along the River. Low impact uses would be facilitated by the development of a *greenway* corridor. An understanding of the value of the tidal habitats would be greatly increased by educational signage in appropriate places along riverside trails.

FURTHER READING
Current information on recreational access along the Hudson can be found in the report issued by the **Hudson River Access Forum (1988)**. Earlier estimates of recreational demand are in the report by the **Hudson River Basin Study Group (1979a,b)**. Extensive technical information on marina design and ways of reducing environmental impacts can be found in the handbook produced by the **U.S. EPA (1985)**. **Fisher et al. (1987)** also examines the impact of marinas. Finally, **Ross (1986)** presents information on marina construction and environmental impacts from a marina owner's perspective.

## Exotic or Invasive Plants
Exotic plants are those that are not native to the Hudson River and have been introduced from other parts of the world (usually overseas) either intentionally or accidentally. Some of these foreign plants have proven to be extremely well-suited to their new environment. A lack of natural predators and diseases enables these species to spread aggressively. Invasive plants are native species that tend to be opportunists, spreading rapidly once a foothold is established. Both exotic and invasive plants can threaten valuable communities by replacing species and by altering the physical environment. Furthermore, the deleterious effects of these plants are often due to or enhanced by human disturbance of the environment. Although the problem of exotic and invasive plants are biological, this subject is presented under shoreline development based on the role that humans play in establishment of these species. Three of the most problematic exotic species are discussed below along with suggested measures of combatting their proliferation.

***Water Chestnut***
Water chestnut is native to southern Europe and Asia (Kiviat, 1987b). It was first brought to Massachusetts about 1875 as an ornamental plant. Water chestnut soon escaped from garden ponds and pools and spread throughout the Northeast. It is a violation of New York law to plant or otherwise enhance the spread of this species.

*Biology*
Water chestnut is an annual that grows in full sunlight on the water surface over depths ranging from less than an inch to 16 feet. The plant has an anchor, a long flexible stem, and one to five or more floating leaf rosettes on the water surface (Figure 24). Water chestnut produces large spiny nuts that mature in late August and can survive over five years before germinating. Plant dispersal also occurs when rosettes break free from the stem, float away, and produce mature seeds. Water chestnut can form very large colonies that cover the water surface (Figure 25).

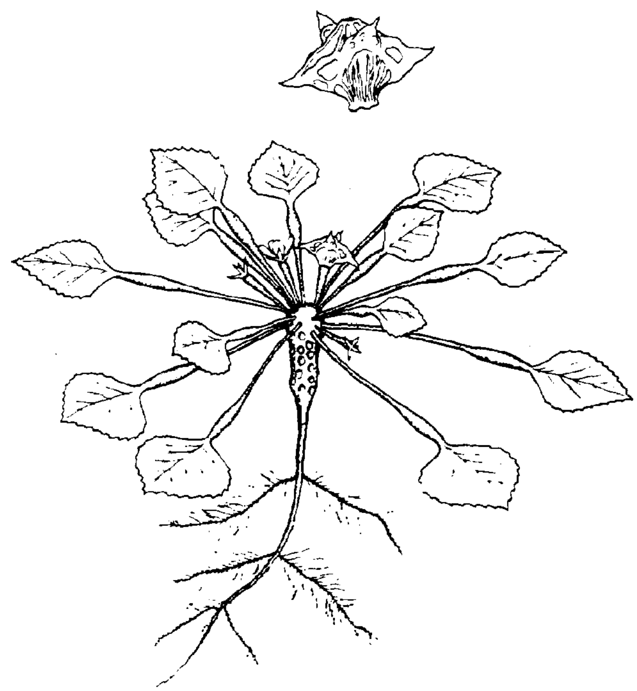


**Figure 24:** *Water chestnut (Trapa natans) (from Kiviat, 1987).*

*Value to Wildlife and Humans*
Although water chestnut in the Hudson is not the Chinese vegetable of the same name, the nuts produced are consumed by muskrats and other rodents. In addition, water chestnut provides shelter for duckweeds and other small floating plants eaten by waterfowl. There is some evidence that they provide nursery ground for young fish. Despite these positive aspects, water chestnut is undesirable for a number of reasons: it often overcomes other more valuable waterfowl food plants; it limits swimming, boating, and fishing; it may lead to sedimentation by reducing current flow; it can lead to reduced oxygen levels; and its large biomass reduces water quality upon decomposition (Kiviat, 1987).

*Habitat Protection Measures*
Several chemical herbicides are effective against the plant; 2,4-D was used by the DEC until 1976 when the permitted application concentrations of the chemical fell beneath effective control levels. Herbicide application has the significant drawback of removing desirable plant species and is not ecologically wise. Water chestnut control through natural biological methods has been explored, including use of a fungus and a beetle. Methods for effective use of these organisms have yet to be developed and more research is needed before the practicality of this approach can be determined.

The only available method for controlling the spread of water chestnut is to remove the plants either mechanically or by hand (Seeger, 1988). Given the long viability of seeds, it is doubtful that even rigorous harvesting efforts would eliminate water chestnut from an area. Nevertheless, periodic harvesting could prove to be useful, particularly if an economic use could be found for the plant material. Potential uses for water chestnut include

**Figure 25:** *Continuous cover of water chestnut over open water at Fishkill Creek (N. Salafsky).*

livestock fodder, methane production, or as a mulch or green fertilizer. Unless effective biological control agents are developed, commercial use of water chestnut represents the only possible means for its safe and effective control.

***Purple Loosestrife***
Purple loosestrife is native to Europe (Malecki, 1987). It was first brought to the east coast in the early 1800's, possibly as seeds carried in ship's ballast or as an ornamental plant. It has spread throughout the continent, often being planted by gardeners or apiarists.

*Biology*
Purple loosestrife is a perennial herb that grows in moist soils associated with wetlands and floodplains. In tidal wetlands, it is generally associated with drier regions of the upper marsh and along the marsh and upland border where it can occur in dense stands. Purple loosestrife is a tall plant (2-8 feet) with squarish stems, opposite lance-shaped leaves, and large panicles of bright purple flowers (Figure 26). Its tiny seeds are dispersed by animals, wind, and water and remain viable for two or more years. Reproduction also occurs by adventitious roots. Plant establishment is often associated with physical disturbance of the existing community.

*Value to Wildlife and Humans*
Purple loosestrife tends to invade throughout a community, reducing or eliminating other plants that are more valuable to wildlife species. Purple loosestrife may create drier marshes, leading to conditions that favor its own proliferation. Although introduction of the plant reduces nesting by some birds that require cattails and other native marsh plants, other birds that traditionally were found less frequently in the marsh nest in loosestrife (Swift, 1988). For humans, the plant has value in honey production and for its appearance.

*Habitat Protection Measures*
Currently, there are no effective means of controlling purple loosestrife, although limited success has been achieved with applications of the chemical herbicide Roundup to individual plants. It is unlikely that wetland areas infested with purple loosestrife can be rid of the plant. Accordingly, efforts must be focused on preventing the spread of the plant (Rawinski, 1988). Loosestrife-free areas need to be identified and protected from disturbance. It may be valuable to systematically inspect loosestrife-free areas on an annual basis so that any invasion could be eradicated before more than a few plants become established.

***Common Reed***
Common reed, while native to the northeast, had been a minor plant found along the coast but has become a highly aggressive weed that takes over communities that suffer any form of human disturbance (Kiviat, 1987a). As such, it is an invasive species in the tidal wetland areas.

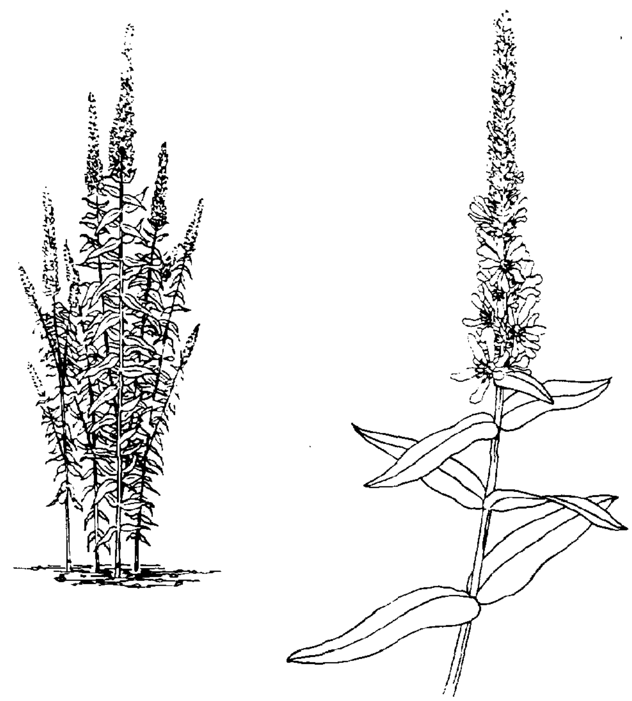


**Figure 26:** *Purple loosestrife (Lythrum salicaria) (from Malecki, 1987).*

*Biology*
Common reed is a perennial grass that grows in moist soil and shallow intermittent surface water. Along the Hudson, common reed thrives in brackish areas such as Piermont marsh, and throughout freshwater sections of the River. Common reed has an underground stem (rhizome) from which annual shoots (culms) grow. The culms have a high concentration of silica which allows the plant to grow between six and thirteen feet tall and support a plumelike inflorescence at its top. Reproduction occurs through both seeds and rhizomes. Common reed often grows in large, dense stands that choke out most other plants (Figure 27). Common reed colonizes areas in response to both natural and human disturbances including changes in drainage, impoundment of marshes, clearing vegetation and exposing soil, dredge spoil deposition, and saline runoff. Shopping malls, residential developments, and roadways are also areas where examples of common reed stands can be found.

*Value to Wildlife and Humans*
As with purple loosestrife, common reed can take over an area, eliminating plants that are more valuable to wildlife species. Unlike loosestrife, however, common reed has

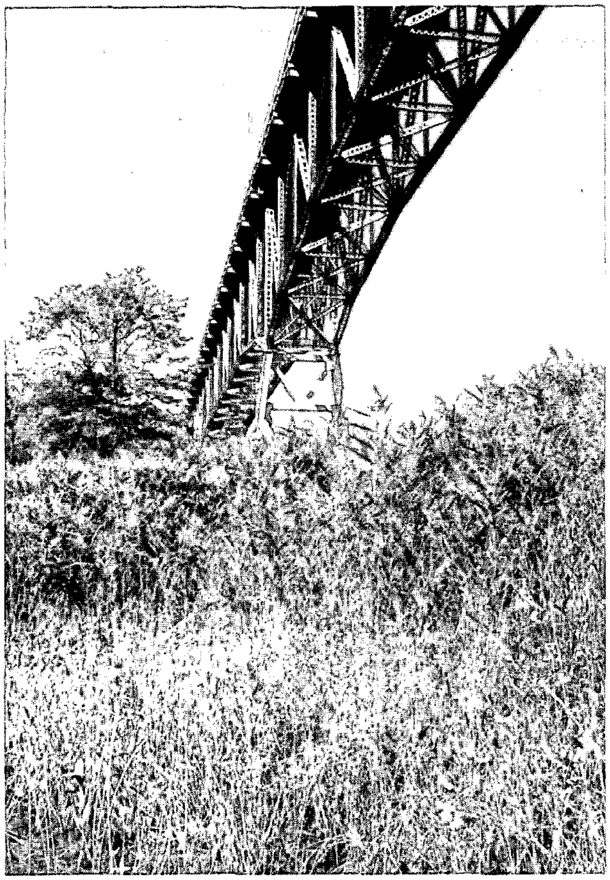


Figure 27: *Common Reed stand below Rip Van Winkle Bridge (N. Salafsky/TNC)*

value for both wildlife and humans. Common reed provides food for muskrats and geese. In addition, several bird species and muskrat use common reed for cover and for building materials. Most of the documented ecological value of common reed comes from European communities. Although common reed is not commercially important on the the Hudson, it is used in Europe and Asia as construction material, fuel, livestock feed, pulp, and ornamental flowers.

*Habitat Protection Measures*

Methods which have been used for control of common reed include herbicides, burning, water level alterations, and mowing. Effective procedures include flooding with ten to twelve inches of water in early June after establishment of the young plants, sudden flooding with sea water, mowing shoots before mid-June, or a combination of these methods. Burning is most effective in early summer just after the shoots emerge or just before the coldest part of winter (Daiber, 1986). In general, however, it is doubtful that these methods would control common reed populations in sensitive tidal marsh communities without causing extensive damage. Common reed control efforts may also lead to promotion of purple loosestrife. To control common reed, efforts must be focused on preventing the spread of the plant to new areas (Rawinski, 1988). As is the case with purple loosestrife, common reed free areas should be identified and protected from disturbance. In addition, marketable uses for common reed should be explored.

FURTHER READING

Descriptions of the biology and control of exotic plants in New York is included in Decker and Enck (1987) from which almost all of the above information is taken.

## 4.6 Use of Living Resources

An unusual characteristic of the Hudson Estuary is the diversity of living things that can be found in the water and its shores. Living resources are becoming more threatened by population growth in the Hudson's watershed and should be rigorously protected now.

### Fishing

Fishing includes both commercial and recreational activities. Although the two types of fishermen can compete for the same resource, they share many concerns for the viability and protection of the resource.

***Issues and Practices***

*Commercial Fishing*

Commercial fishing has been a major industry for much of the history of the Hudson River. The mainstay of the fishing industry has been the huge spawning runs of American shad, Atlantic sturgeon, and striped bass. A hundred years ago, Albany was known for its sturgeon and caviar exports. The fish was so plentiful that it was known as "Albany beef" and laws were passed forbidding its being given to servants more than once a day (Chhabra, 1988). Likewise, caviar, which was exported as far as Russia, was given away in waterfront saloons in hopes that its saltiness would spur drink sales. Oysters and other shellfish harvested from the lower portions of the estuary were also an important source of revenue.

Starting in the twentieth century, however, commercial fishing along the Hudson declined due to water pollution, habitat loss, and stock depletion. Urban pollution eliminated the oyster beds as early as 1925, and subsequently, other species declined dramatically. Since the Korean War, fishing has become unprofitable for most professionals; the number of regular commercial fishermen going out each spring has dwindled from 71 in 1935 to a low of 31 in 1974. Finally, commercial fishing almost completely halted in 1976 with the discovery that many fish in the River had PCB contamination levels that far exceeded Federal allowances for food consumption.

As a result of PCB contamination, the River north of the Troy dam was closed to fishing. The commercial fishery in the southern portion of the River was limited to American shad and Atlantic sturgeon, two species which primarily feed in the open ocean and return to the River to spawn. In 1983, the commercial fish harvest from the Hudson River totalled 554,000 pounds with a value of $162,900 (Horn and Skinner, 1985). In recent years however, the shad catch alone has been over a million pounds annually. Marketing the catch is hampered by an undeserved reputation of Hudson River fish among consumers and severely depressed prices due to the large volume of fish on the market caught in earlier spawning runs from more southern waters.

Commercial fisheries are linked to the health of the River. Since PCB discharges in the River were curtailed in 1977, PCB levels in many species have been falling. With cleaner waters and less fishing pressure, fish populations may have increased. Attempts are even being made to revive the caviar export industry and sales of smoked Atlantic sturgeon are rapidly rising (Chhabra, 1988). The fishing industry may continue to improve with improvement in the River's environmental quality and adequate management of the resource.

*Recreational Fishing*

Over the last century, recreational fishing surpassed commercial fishing in economic importance in the Hudson River. In 1976 it was estimated that over 50,000 angler days were spent on the River and that an additional 1,417,000 angler days were spent on the coastal striped bass fishery, which is supported in part by the Hudson Estuary (Sheppard, 1976 *in* MPI, 1983). Recreational fishing is an important part of the State economy. In 1978 it was estimated that freshwater fishing in New York State generated between 385-448 million dollars in economic activity, while marine fishing added an additional 625-646 million dollars (Skinner, 1979 *in* Horn and Skinner, 1985). Economic activity is directly related to environmental quality: estimates indicate that PCB contamination costs the State between $17 and 25 million annually in lost fishing revenues (Barclay, 1989). Fishing is also important as a recreational pastime. A survey of a large sample of licensed anglers in 1977 revealed that most people fish to be outdoors and for the fun, sport, and skill challenges it provides (Horn and Skinner, 1985).

Most of the issues facing recreational fishing today on the Hudson are related to toxic substances in water and fish. Fishing is completely prohibited between Troy and Hudson Falls due to PCB contamination. In the estuarine portion of the River (including tidal portions of tributary streams), where fishing is permitted, it is recommended that American eel, white perch, carp, goldfish, brown bullhead, largemouth bass, pumpkinseed, white catfish, striped bass, and walleye should not be eaten at all, and no more than one meal a month should be eaten of black crappie, rainbow smelt, Atlantic needlefish, northern pike, tiger muskellunge, and bluefish (DEC, 1988). Other sources of controversy are centered on River access.

***Impacts of Fishing***

*Species Depletion*

At the peak of the Hudson's commercial fishing industry, it is likely that overfishing contributed significantly to the decline in many fish populations. Current bans on fishing for most species, however, may provide protection for the fish stocks. If the industry revives, intensive fishing could reduce the populations of many species. This potential problem would be especially acute for anadromous fish since it is relatively easy to catch these fish during the spawning runs. Determining how many fish must be allowed to spawn is not a simple task. Although most fish have the capacity to produce hundreds or thousands of eggs per female, the eggs and larvae suffer a high mortality rate. Large numbers of eggs may be necessary to ensure that enough individuals survive to reproduce and sustain the population. Many fish are also lost through impingement and entrainment in water intakes. Both natural and human causes of mortality must be considered in setting limits on a sustainable harvest.

*Ecosystem Effects*

Both recreational and commercial fishing have little impact on tidal habitats, provided that depletion of species does not occur. Adverse ecosystem effects that may be related to fishing or fishery management include: loss of nutrient input that anadromous fish carry into the ecosystem in the form of eggs; loss of higher level predators that regulate other populations; and, introduction of exotic fish species into the River for recreational fishery development. Over the last few decades, it is quite likely that the tidal habitats have benefited more from the efforts of fishermen (especially the Hudson River Fisherman's Association) in the control of River pollution than they have been adversely impacted by fishing practices.

***Habitat and Fish Population Protection Measures***

The greatest threat to both fish populations and the fishing industry is the loss of suitable habitat. Accordingly, fishermen and conservationists must work together to preserve as much habitat in the River as is possible. Both recreational and commercial fishing would be greatly improved if all fish in the River were safe to eat. Local fishermen can play an important role in working to eliminate toxic discharges in their towns and counties. Effective management of the fishery resource requires close cooperation between fishermen and the DEC.

FURTHER READING

Information on commercial and recreational fishing along the Hudson can be found in reports of the DEC Hudson River Estuary Fishery Management Program such as **Dunwell (1984)**. Problems with toxic pollution and fish are reviewed in **Horn and Skinner (1985)**. Current fishing regulations can be found in guides produced by the DEC.

## Other Natural Resource Uses

Other recreational use of natural resources includes *consumptive* activities such as hunting and *passive* activities such as bird-watching and scientific study.

### *Issues and Practices*

*Hunting and Trapping*
Hunting, as a consumptive use, has been practiced in the forests and wetlands of the Hudson since humans first inhabited the Valley. Accounts of the Algonquian and early colonial days describe a land full of game animals and waterfowl that were easily taken. In subsequent years, the animals dwindled in numbers and species and are no longer a primary food source for most people. Nonetheless, wetlands and forests of the Hudson today still support hunting and trapping. By far the most popular game are ducks and geese that stop briefly in wetlands to feed and rest during fall migrations. Trappers focus on muskrats, minks, and other furbearing animals of the marsh and swamp communities.

*Non-consumptive Nature Experiences*
Nature experiences are difficult to quantify or evaluate since they occur in so many varied forms. In our increasingly urbanized environment, the River provides an opportunity to escape from the crowds, noise, and sights of the cities and their suburbs. Activities that satisfy this passive recreational need include birdwatching, photography, painting, walking, hiking, biking, sailing, swimming, sitting, and many others. Important considerations that affect the quality of nature experiences are safe, readily available access to sites, limits on outside noises and pollutants, limits on the number of people present, and the physical condition of the sites. In order to provide high quality experiences, it is necessary to actively manage for this use. Unfortunately, there is a presumption that these uses can normally be accommodated as an ancillary activity to some other economically attractive use.

*Scientific Research*
The proximity of the Hudson River to many universities and other scientific institutions makes it an excellent resource or laboratory for research on physical and biotic aspects of the estuarine environment. Research is vital to further our understanding and future management of the ecosystem. Scientific work conducted on the Hudson benefits management of the region directly and increases the level of knowledge that is necessary to protect our environment effectively.

### *Impact of Recreational Use of Resources*

*Consumptive Activities*
Impacts from hunting and trapping include intentional or accidental killings of protected animal species, disturbance of animal populations, minor disruption through the construction of deer stands and duck blinds, and pollution of the habitats with lead shot (recently banned in New York for waterfowl hunting). Positive impacts of hunting include the regulation of overabundant animal populations and habitat conservation efforts conducted by hunting clubs and financially supported by hunting fees.

*Non-consumptive Activities*
Passive observations of the natural environment have little or no impact on the habitats save disturbance of a few species (e.g. bald eagle or least bittern) caused by human presence, and whatever alterations that are needed to enable human access to the area. Hikers and hunters can also trample valuable plant species and leave litter behind. Passive scientific studies generally do not have negative impacts. Studies involving active habitat manipulation, however, may create adverse impacts that have to be evaluated against the benefit of potential knowledge to be gained.

### *Habitat Protection Measures*

As is the case with fishing, the greatest threat to hunting is the loss of suitable animal habitat. Accordingly, hunters and other conservationists must work together to preserve habitat in the River as much as possible. Local hunters can play an important role in working to preserve suitable habitats in their towns and counties. Effective management of the wildlife resource requires close cooperation between hunters and the DEC.

Passive uses of the habitats should be strongly encouraged. The River ecosystem will only be preserved to the extent that people appreciate its beauty and value. In providing access to the River, care should be taken to educate all users to the sensitive nature of the habitats and how their presence may affect the system. Scientific research on our basic understanding of the ecosystem, its component communities and species, the impact of human actions, and the management of the resource are also vital and should be promoted. At the same time, however, it must be realized that research is not always linked to conservation efforts and overzealous habitat manipulations can destroy far more habitat value than the knowledge gained can save. Scientists, universities, and funding agencies should ensure that research observes protection of the resources as a primary concern and is conducted in an appropriate manner.

FURTHER READING
For information on access to the habitats, see the report by the **Hudson River Access Forum (1988)**. DEC's hunting and trapping regulations are published annually.

Chapter 5:

# EXISTING RESPONSIBILITIES FOR RESOURCE MANAGEMENT

---

*This chapter examines the legal and political framework that governs human activity along the tidal portion of the Hudson River. The first section briefly reviews the major legislation that applies to the River habitats. The next section identifies government agencies that implement and enforce these laws. The final section looks at a few of the private organizations that actively promote protection of the Hudson River's resources. A list of these agencies and groups together with their addresses is given in Appendix D.*

*The information in each section is presented at three levels: national, state, and local.*

---

## 5.1 Legislative Background

Legislative efforts impacting natural resources have tended to facilitate resource exploitation for economic reasons. For example, the Swamp Lands Act of 1849 gave states title to their wetland areas so they could "reclaim" them for productive uses. Increasing public awareness of environmental issues over the last two decades has led to the adoption of a wide range of environmental legislation at Federal, State, and local levels. A complex framework of laws and regulations now governs the use of the Hudson River and the protection of its habitats.

## Federal Legislation

***Rivers and Harbors Appropriations Act (Refuse and Navigation Acts)***

The 1899 Rivers and Harbors Appropriations Act is one of the earliest federal laws regulating water pollution. Section 10 of this law empowers the U.S. Army Corps of Engineers to regulate all dredging and filling in navigable waters through a permit system. Section 13 prohibits disposal of refuse from any vessel or shore facility in navigable waters; this section of law has not been interpreted as empowering the federal government to impose regulations regarding hazardous waste discharges. Navigable waters include all tidal waters and adjacent lands up to the unobstructed natural high water mark. The Rivers and Harbors Acts of 1925, 1930, 1938, and 1954 authorize the Corps to dredge the Hudson River to legislatively prescribed dimensions to provide waterborne access to the Port of Albany.

***Fish and Wildlife Coordination Act (FWCA)***

The 1965 FWCA requires that federal agencies coordinate their activities to meet federal conservation goals. Specifically, the Act requires each federal agency to consult with the Fish and Wildlife Service concerning potential impacts of proposed activities on endangered and threatened species.

***National Environmental Policy Act (NEPA)***

The NEPA, which became effective in 1970, was the first major attempt to establish a national policy for the protection of the quality and condition of the environment (Freedman, 1987). NEPA was enacted to ensure that proposed Federal agency actions are carefully evaluated before they are undertaken to avoid potential damage to the nation's air, land, and water resources. Under Title 1 of NEPA, a proposed agency action that could adversely affect the human environment must have its implications fully detailed in an environmental impact statement (EIS). Copies of the EIS must be made available to the public and submitted to the Council on Environmental Quality (CEQ), an executive advisory board created under Title 2 of NEPA. NEPA does not require that potential adverse impacts be avoided, but only that they be identified and alternatives to the proposed action be evaluated.

***Coastal Zone Management Act (CZMA)***

The 1972 Coastal Zone Management Act encourages states to work in cooperation with federal and local governments to develop land and water use programs for coastal waters and adjacent shorelands. Amendments to the Act in 1976 and 1980 require funding recipients to focus on shorefront access and the preservation of areas of unique ecological, historical, and scenic importance. The act is administered by the National Oceanic and Atmospheric Administration (NOAA).

***Marine Protection, Research, and Sanctuaries Act***

The 1972 Marine Protection, Research, and Sanctuaries Act establishes the National Estuarine Sanctuary Program which provides matching grants to states to acquire, develop, and manage estuarine areas to be used for scientific research and education. The Hudson River National Estuarine Sanctuary System was established in 1982 under the guidelines of this program. The Act is administered by NOAA.

***Endangered Species Act***

The 1973 Endangered Species Act is designed to protect species of fish, wildlife, and plants which are listed as either in danger of extinction *(endangered)* or are likely to become an endangered species in the future *(threatened).* Under this Act, it is illegal to import or export any federally listed species. In addition, federal agencies must ensure that their actions will not jeopardize the continued existence of endangered and threatened species and that such actions do not destroy or impair habitats that are determined by the Secretary of the Interior to be "critical" to the survival of listed species.

***Clean Water Act (CWA)***

The 1977 CWA incorporates several earlier water pollution control measures including the 1972 Federal Water Pollution Control Act. Enforcement mechanisms and regulatory procedures of the CWA were amended by the 1987 Water Quality Act. The CWA was enacted to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (Freedman, 1987). The CWA established the National Pollution Discharge Elimination System (NPDES) that requires the EPA to administer a permit system limiting the amounts of listed pollutants that can be discharged into the waters of the nation (see the description of SPDES under NYS laws for a more detailed account of the NPDES process). In the 1987 Water Quality Act, the EPA is given additional authority to establish a program controlling nonpoint source pollution. Section 404 of the CWA requires a federal permit to be issued by the Army Corps of Engineers for discharge of dredged or fill material into navigable waters. The 1987 Water Quality Act also has a provision directly addressing water pollution problems in the nation's estuaries.

***Other Federal Acts***

The 1968 **Wild and Scenic Rivers Act** establishes a program to designate certain rivers as being of wild, scenic, or recreational importance, and prohibits dams and other structures from being placed on designated rivers. Three segments of the lower Hudson River have been identified for inclusion in the program: from Barrytown to Malden; Hudson to Coxsackie; and Coxsackie to New Baltimore.

The 1974 **Deepwater Port Act** provides for "the protection of the marine and coastal environment to prevent or minimize any adverse impact which might occur as a consequence of the development of such ports."

The 1980 **Act to Prevent Pollution from Ships** restricts ships of U.S. registry, wherever located, and ships of foreign registry in the navigable waters of the U.S. from discharging oil, oily mixtures, or noxious liquids into the water except under certain defined conditions.

The 1980 **Superfund Act** requires that the public be notified of the release into the environment of any substances that may present a substantial danger to public health or the environment. The Act also establishes two funds financed by taxes on oil and hazardous materials to be used to clean up hazardous compounds and compensate the public for damages caused by the release of these substances.

## State Legislation

***Environmental Conservation Law (ECL)***

The ECL contains the general authorization for the activities of the Department of Environmental Conservation (DEC) and many specific laws addressing a variety of environmental issues.

*Article 8: State Environmental Quality Review Act (SEQRA)*

Under this Act, which is New York State's version of the NEPA, State agencies and local governments are required to prepare an environmental impact statement (EIS) for any action which may have a significant effect on the environment. In accordance with Article 42 of the Executive Law, the SEQRA regulations were amended to require state agency actions to be consistent with coastal policies.

*Articles 11 and 13: Fish and Wildlife Law*

Article 11: Fish and Wildlife and Article 13: Marine and Coastal Resources comprise the parts of the ECL which regulate hunting, trapping, and fishing in the lands and waters of New York State.

*Title 3, Sec. 6: Hudson River Estuary Management*

This program establishes the Hudson River Estuarine District which encompasses the tidal waters of the River and its tributaries and wetlands between the dam at Troy and the Verrazano Narrows. The program is administered by the DEC through an advisory committee and a coordinator within the DEC. The committee is charged with recommending a DEC management strategy that provides for the preservation, protection, restoration, and enhancement of the Estuarine District. This section also addresses the State's participation in the Federal Hudson River National Estuarine Research Reserve.

*Title 5, Sec. 35: Endangered Species*

This section provides for the designation of endangered and threatened species by the DEC and prohibits the taking or sale of any of these species.

*Article 15: Water Resources*

Water Resources regulations address a wide range of water management activities including reservoirs and reservoir releases, water resources planning and development, water supply, hydroelectric power, and river use and improvement.

*Title 5: Protection of Water*

This program requires a permit to be issued by the DEC for activities in streams, rivers, ponds, and lakes including disturbance to stream beds or banks, construction or repair of certain dams, and excavation or fill in navigable waters. Under the program, for "protected" streams (those classified for certain purposes such as drinking or swimming), permits are required for activities that will disturb or change the stream bed or its banks within 50 feet of the edge of the stream. Construction and repair of dams also require permits within certain thresholds regardless of the navigability or classification of the water body. In navigable waters (those on which a canoe or larger craft can be operated), permits are required for any dredging and filling in the water and in adjacent wetlands.

*Title 27: Wild, Scenic, and Recreational Rivers System*

Under this program, stretches of rivers in New York can be designated as important "wild," "scenic," or "recreational" resources. This law authorizes the DEC to protect the outstanding natural, scenic, historic, ecological, and recreational resources of these rivers.

*Article 17: Water Pollution Control Act*

The Water Pollution Control Act regulates the discharge of pollutants and sewage into the waters of New York and controls the bulk storage of petroleum.

*Title 8: State Pollutant Discharge Elimination System*

Pursuant to the 1972 Federal Water Pollution Control Act, all direct dischargers into the nation's surface waters are required to obtain permits that regulate the amount of certain substances that they release. Under this act, the National Pollutant Discharge Elimination System (NPDES), the EPA was authorized to set up national water quality standards for the maximum in-stream concentrations of various pollutants allowable that would still protect the health of humans and aquatic organisms. In the provisions of the legislation, all states are required to establish their own water quality control programs using either the EPA standards or their own standards which had to be at least as stringent as the EPA's. In New York State, the DEC chose to develop its own standards for the amounts of pollutants that are allowable. As of 1987, the DEC had established "standards" (legally binding) for 95 hazardous substances and "guidelines" (challengeable in court) for 100 additional substances.

The standards established by the DEC are used to limit amounts of various pollutants that a given manufacturer or sewage plant can discharge into the River under a SPDES (pronounced "speedeez") permit. The limits for any given water body are determined using scientific information concerning the effects of different concentrations of these substances on humans and animals and the usage classification of the given body of water. A SPDES permit contains the specific effluent limits for each substance that is to be released, self-monitoring requirements, a compliance schedule for construction of treatment systems, and any special regulations. SPDES permits are valid for five years and are divided into several categories depending on the size and type of the discharging plant. Compliance with the SPDES permit is largely based on information supplied by the discharger. Although the DEC has the power to fine violators or to suspend or revoke a permit, the DEC has had a general policy of seeking voluntary compliance in order to gain the greatest reduction in pollution without the delays that are inherent with litigation.

*Article 24: Freshwater Wetlands Act*
The Freshwater Wetlands Act of 1975 recognizes the value of freshwater wetlands in providing flood protection, wildlife habitats, open space, and water resources. The program established under this Act regulates activities potentially detrimental to wetlands such as draining, dredging, and filling. It is administered by the State or local governments pursuant to State guidelines following official filing of wetland inventory maps by the State. The DEC regulates freshwater wetlands through an interim permit program in communities where maps have not yet been filed. Before granting or denying a permit, the municipality or the DEC must determine whether the activity will have an adverse impact on the value of the wetland. The Act covers wetlands that are greater than 12.4 acres in size although smaller tracts can be included if they are of special importance. Regulations apply to the mapped wetland and to a buffer zone extending 100 feet in all directions from the border of the wetland.

*Article 25: Tidal Wetlands Act*
The Tidal Wetlands Act of 1973 serves to preserve and protect tidal wetlands from despoliation and destruction. Under the terms of the Act, the DEC inventoried and mapped all tidal wetlands and developed a permit system to govern their use. A permit for development in a tidal wetland can be issued only if it can be demonstrated that proposed activities will not adversely affect water quality, flood and storm control, marine food production, wildlife habitats, open space, and aesthetically significant areas. On the Hudson, the Tidal Wetlands Act applies from the ocean to the Tappan Zee Bridge. Regulation of mapped tidal wetlands includes a buffer area that extends 300 feet from the landward boundary of the wetland or to an elevation of 10 feet above mean sea level (whichever is closer). Unlike the Freshwater Wetlands Act, this Act does not have a regulated wetland size limitation. The Act is enforced by the DEC and its administration cannot be delegated to local governments.

*Article 34: Coastal Erosion Hazard Areas Act*
The Coastal Erosion Hazard Areas Act provides the authority to regulate and control certain activities and development in coastal erosion hazard areas within the State's coastal area, including the estuarine portion of the Hudson River. Within coastal erosion hazard areas, construction or placement of a structure, or any action or

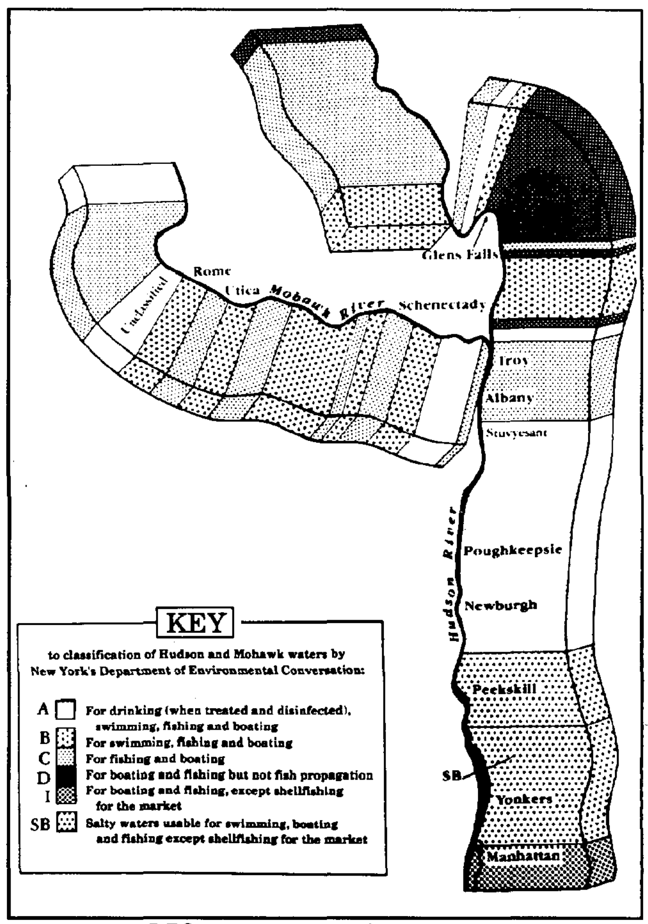



**Figure 28:** *DEC water use classifications along the Hudson River (From Rohmann and Lilienthal, 1984).*

use of the land which would materially alter the condition of the land requires a permit from the DEC, or county or local government, whichever has assumed jurisdiction. Coastal erosion hazard areas include: "structural hazard areas" which are receding at an average rate of one foot or more per year; and "natural protective feature areas" which include beaches, dunes, sandbars, spits, shoals, barrier bays, barrier islands, bluffs, and wetlands.

*Executive Law (EL)*
The EL contains the legal authority for the State's coastal management program which is administered by the Department of State.

*Article 42: Waterfront Revitalization and Coastal Resources Act*
Article 42 declares in part that it is the public policy of the State within its coastal area to: conserve and protect fish and wildlife and their habitats; achieve a balance between economic development and preservation needs that permits the beneficial use of coastal resources while preventing permanent adverse changes to ecological systems; and to minimize damage to natural resources and property from flooding and erosion. The Act's policies also call for the assurance of consistency of State actions and Federal actions with policies within the coastal area and cooperation and coordination with other states, the Federal government, and Canada to attain a consistent policy towards coastal management. Consistency is accomplished by requiring that all activities in the coastal area involving a federal permit be reviewed by the DOS to ensure that the action is consistent with the State's policies. Section 919 of Article 42 also requires that State agencies' actions including funding, planning, and land transactions, as well as direct development activities, must be consistent with the policies of the Act. Coordination of this provision is achieved in part through SEQRA.

## Local Legislation

Local governments in New York State are comprised of counties, cities, towns, and villages. These units of government provide most local government services. Local governments are based on the State Constitution and statutes for the basic law which provides for their structure, powers, and operational procedures. Important State Constitutional provisions relevant to local governments are found in Article IX (home rule) which gives local governments the power to adopt local laws and Article VIII (finance) which provides for tax collections. Provisions pertaining to the specific powers and duties of local governments are also found in various State statutes.

Under the principle of home rule, local governments may pass a variety of laws, ordinances, and resolutions. Specific details of these laws vary from municipality to municipality but they tend to share general features. Zoning ordinances and the development of waterfront revitalization plans are of special importance to the future of the tidal habitats in the Hudson.

***Planning and Land Use Regulation***
Land use regulation by local government is derived from the police power that local governments have to provide for public order, peace, health, safety, morals, and general welfare. In the early 1900's, local governments began to use this power to plan and control their development. Municipal governments have the authority to create planning boards that advise local governments concerning appropriate and inappropriate uses of lands in their municipalities. The recommended uses are then codified in the form of zoning ordinances which regulate the types of land use that are permissible in each zone. Variances can be issued to permit the use of land in a manner for which it is not zoned, provided certain conditions are met.

***Local Waterfront Revitalization Programs (LWRPs)***
Under provisions of the Federal and State coastal management programs, funding and technical assistance are available to coastal municipalities to prepare and implement local LWRPs. Through local programs, municipalities may refine and supplement state coastal policies to reflect local conditions and needs. Preparation of a LWRP includes an inventory of waterfront resources and conditions, identification of problems and opportunities and development of local policies which are consistent with state policies, preparation of specific waterfront proposals, and enactment of local laws and regulations to implement policies. Once a municipality's LWRP has been approved by the Secretary of State, the local program may be substituted for the state program in that community. State and federal actions must then be consistent with the approved LWRP. The State program makes funds available to help implement specific waterfront projects proposed in the local program.

FURTHER READING
Those interested in learning more about environmental legislation and related implementing regulations should begin with commentaries on and summaries of the statutes which present both the intent of the law and its interpretation by the courts. Direct reading of the law often does not provide an adequate context for understanding how the law addresses a particular issue. Useful sources on Federal environmental legislation include **Freedman (1987)** and **Firestone and Reed (1984)**. No complete summary of New York State environmental law is currently available; information in this section was taken primarily and directly from the text of the Environmental Conservation Law of the State of New York as reprinted **(Looseleaf Law Publishing, 1988)**. A summary of local government law can be found in The Local Government Handbook, **DOS (1987)**.

## 5.2 Government Agencies

Numerous agencies have jurisdiction over different aspects of the Hudson River. This section is adapted from New York's Eastern Lake Ontario Sand Dunes: Resources, Problems, and Management Guidelines (DOS, 1989).

### Federal Agencies

***Army Corps of Engineers (Corps)***

The Hudson River is within the jurisdiction of the New York District of the Corps of Engineers, with headquarters located in New York City.

The Corps regulates structures in, or affecting, navigable waters of the U.S., as well as excavation of or deposition of materials in navigable waters. The Corps is also responsible for evaluating applications for Department of the Army permits to deposit dredged and/or fill material into the waters of the U.S. including adjacent wetlands. In general a permit must be obtained from the Corps for: filling of wetlands and navigable waters; placement of structures in navigable waters; dredging; and disposal of dredged materials.

The Corps is also responsible for Federal navigation projects (e.g. channels, jetties, anchorages) specifically authorized by Acts of Congress. In the Hudson, this includes the shipping channel up to Albany and auxiliary channels in six tributary streams which the Corps constructed and is responsible for maintaining.

***Environmental Protection Agency (EPA)***

The EPA is the primary federal agency for administering and enforcing federal environmental laws such as the Clean Water Act and NEPA. The Hudson River estuary is under the jurisdiction of the Region II office of the EPA in NYC which works to maintain water quality values in the River and comments on applications for dredging and filling submitted to the Corps of Engineers. Under Section 404 of the CWA, Corps permit decisions are made under EPA guidelines and the EPA has the authority to veto issuance of a permit during the review process. The EPA can also take enforcement actions against unauthorized activities, impose civil fines, and seek criminal penalties. The EPA has also worked to identify important wetland areas in the U.S. Many of the specific habitats presented in this guide are also identified under the EPA program.

***National Oceanic and Atmospheric Administration (NOAA)***

NOAA is the branch of the Commerce Department that administers the Federal Coastal Zone Management Program under which the New York State Coastal Management Program is authorized and under which the Estuarine Sanctuary Program operates. In addition, NOAA contains the **National Marine Fisheries Service (NMFS)** which is a research and applied science agency charged with the protection and enhancement of fishery resources and their habitats. Responsibilities include review and analysis of all development activities waterward of the high tide line of the Hudson up to the Troy dam, and special projects to the headwaters. NMFS is also responsible for management of the Endangered Species Act, with the Shortnose Sturgeon being a major concern in the Hudson.

***Department of the Interior (DOI)***

The Department of the Interior contains the **National Park Service** which administers several historic sites located along the Hudson, the **United States Geological Survey (USGS)** which makes maps and conducts surveys and hydrodynamics research in the estuary, and the **Fish and Wildlife Service (FWS)**.

The FWS monitors endangered species, migratory birds, and contaminants in fish and wildlife resources. The FWS is also involved in reviewing permit applications for navigation, flood control, power, and highway projects. The FWS's Cortland, New York field office considers and comments on impacts on wildlife and marine resources resulting from proposed development projects requiring Corps permits. If the FWS determines that a proposed development action will cause a habitat loss, the Service can recommend mitigation measures to avoid, or minimize and compensate for, such loss.

### State Agencies

***Department of Environmental Conservation (DEC)***

The DEC has both resource management and regulatory responsibilities for the tidal habitats of the Hudson River. DEC's central office in Albany establishes statewide policies and regulations and provides technical assistance to the regional DEC offices. Three regional offices have jurisdiction over the estuarine portion of the Hudson River: Region 2, headquartered in New York City, has jurisdiction over the River in New York City; Region 3, headquartered in New Paltz, has jurisdiction over the Hudson in Rockland, Westchester, Orange, Putnam, Ulster, and Dutchess counties; while Region 4, headquartered in Schenectady, has jurisdiction over the Hudson in Greene, Columbia, Albany, and Rensselaer counties.

*Management Responsibilities*

The DEC's management responsibilities are directed towards fish and wildlife resources and focus on the various wildlife management areas established within the estuary. Responsibility for managing these areas rests with the DEC Division of Fish and Wildlife in each regional office. DEC conservation officers responsible for enforcing management rules and regulations are within the Division of Law Enforcement. General wildlife management rules and regulations are established by the DEC to apply to all wildlife management areas. In addition, special rules and regulations have been established for some areas, particularly those with significant waterfowl habitat and wetland areas. The DEC-managed areas along the tidal portion of the Hudson include Roger's Island and Tivoli Bays. The DEC also has jurisdiction over rivers in the State outside the Adirondack Park through the New York State Wild, Scenic, and Recreational Rivers System Act which includes three stretches of the lower Hudson River.

*Regulatory Responsibilities*
The DEC has the major responsibility for protecting natural resources in the coastal area of New York State and exercises this authority through permit, review, and management programs. For example, DEC reviews proposed development activities with the potential for significant environmental impact in accordance with the requirements of the State Environmental Quality Review Act (SEQRA), the Freshwater and Tidal Wetlands Acts, Protection of Water, the State Pollutant Discharge Elimination System (SPDES), and the Coastal Erosion Hazard Areas Act. The DEC also implements the Environmental Quality Bond Act and is empowered to acquire property.

*Hudson River Estuary Management Plan*
Under Article 11 of the ECL, the DEC is developing a 15-year policy setting plan to manage the Hudson Estuary. This plan provides a long-term focus for actions that affect the River ecosystem.

***Department of State (DOS)***
The DOS, through its Division of Coastal Resources and Waterfront Revitalization, administers the New York State Coastal Management Program (CMP) and coordinates activities essential to its implementation. Authority for the CMP was established by the State Waterfront Revitalization and Coastal Resources Act of 1981. The CMP covers the shores of Lakes Erie and Ontario, the Niagara and St. Lawrence Rivers, the tidal portions of the Hudson River, New York City, and Long Island.

*Protection of Coastal Resources through Consistency Review*
Actions proposed in the coastal area of New York State by federal agencies or by applicants for federal permits (e.g. from the Corps of Engineers) must be consistent with the policies established by the CMP. If a proposed action is determined to be inconsistent by the DOS, a federal permit can not be issued. The DOS also evaluates the consistency of federal direct actions such as dredging and funding with respect to coastal policies. In addition to federal activities, state agency activities are also required to be consistent with the coastal policies. Each state agency that proposes to fund or undertake an action in the coastal area must determine the consistency of its action with the policies and purposes of the CMP. State agency permit decisions must also comply with the coastal policies when the proposed permit action is the subject of an environmental impact statement or when there is an approved local waterfront program.

*Special Area Designations*
The DOS is responsible for ensuring the protection of coastal fish and wildlife habitats, scenic areas, and agricultural lands of statewide significance. Once areas are designated, the coastal management consistency requirements can be used to protect these resources.

Significant Coastal Fish and Wildlife Habitats may be designated by the State if the DEC determines that the habitat is: essential to the survival of a large portion of a particular fish or wildlife population; supports populations of species which are endangered, threatened, or of special concern; supports populations having significant commercial, recreational, or educational value; or exemplifies a habitat type which is not commonly found in the State or in a coastal region. The significance of certain habitats increases to the extent they could not be replaced if destroyed. The tidal portions of the Hudson currently include 34 sites designated as Significant Coastal Fish and Wildlife Habitats. In addition to the Significant Coastal Habitat Program, the DOS has recently begun a program to identify, evaluate, and recommend areas for designation as Scenic Areas of Statewide Significance.

*Special Interest in the Hudson River Tidal Habitats*
The unique values of the Hudson Estuary became particularly evident during the identification phase of the Significant Coastal Habitat Program. The River contains one of the highest concentrations of designated habitats, as well as some of the highest valued habitats in the State. Because of this uniqueness and the DOS's concern that the habitats are being adversely impacted by human activities along the River, the DOS initiated and funded a special study (presented in this report) of the tidal portion of the Hudson River.

***Office of Parks, Recreation, and Historic Preservation (OPRHP)***
The main responsibility of the OPRHP is to operate and maintain a statewide system of parks and historic sites to meet the recreational needs of the people of the State. The State Parks and Recreation Law authorizes the OPRHP to acquire, establish, operate, and maintain state parks, parkways, historic sites, and state recreational facilities. The Parks and Recreation Bond Act provides a source of funds for acquisition. Within the framework of the OPRHP, the **Palisades Interstate Park Commission (PIPC)** operates as a semi-autonomous entity that administers the Interstate Park System along the lower western shore of the Hudson.

OPRHP establishes rules and regulations for state park use. OPRHP administered parks in the tidal portion of the Hudson include the undeveloped Castleton Island State Park (on Schodack and Houghtaling Islands) and the Hudson River Islands State Park (on Gay's Point and Stockport Middle Ground). The Iona Island and Piermont Marsh sites are managed in part by the PIPC.

OPRHP is also responsible for administration of the State's Navigation Law. The OPRHP's Bureau of Marine and Recreational Vehicles has general responsibility for boating safety in New York State and provides funding and training for marine law enforcement as well as boating education programs. Also, under the Navigation Law and Town Law, no local law or ordinance pertaining to the regulation of vessels and establishment of vessel regulation zones can take effect until it has been submitted to and approved by OPRHP.

***Hudson River National Estuarine Research Reserve (HR-NERR)***
The HR-NERR program is authorized under the Federal Coastal Zone Management Act and is administered by State government. The DEC has primary responsibility for the program but works in cooperation with the Department of State, OPRHP, and the Office of General Services. The HR-NERR is headquartered at the Bard College Field Station and operates in conjunction with DEC Region 3 offices in New Paltz.

The HR-NERR consists of four reserve sites along the Hudson River at Stockport Creek, Tivoli Bays, Iona Island, and Piermont Marsh. The estuarine research reserves are used for scientific research and environmental education. Currently, 4,130 acres of habitat are included in the four estuarine sites. Much of the land was already owned by the State when the program began, while additional lands were purchased through a grant from NOAA and matching State funds.

***New York Natural Heritage Program***
The Natural Heritage Program was established with funding provided by The Nature Conservancy and is now jointly funded by The Nature Conservancy and the DEC. Major purposes of the Heritage Program include inventorying rare plant and animal species and natural communities in the State, compiling information on the occurrences of these species and communities, and providing these data to interested parties. In conducting the statewide inventory, the Heritage Program applies a standardized methodology developed by The Nature Conservancy for ranking species and communities on the basis of their rarity both in the State and globally. Sites in the Hudson River Estuary have been identified that support many rare species and communities.

***Office of General Services (OGS)***
The OGS administers state-owned lands including all land that is below the high tide mark along the coast. Under the Public Lands Law, most private uses of submerged land within the public domain require a grant, easement, or lease from OGS. In the past, the State has sold or granted significant portions of the Hudson River shoreline and underwater lands for various commercial uses.

***Department of Health (DOH)***
The DOH enforces the Public Health Laws and the State Sanitary Code by which it regulates restaurants, motels, campgrounds, and other specific activities. The Department of Health must also approve water and sewage provisions for commercial uses and realty subdivisions. DOH also issues advisories regarding consumption of fish caught in the River.

## Local Agencies

Counties bordering on the estuarine portion of the Hudson River include Albany, Rensselaer, Greene, Columbia, Ulster, Dutchess, Orange, Putnam, Rockland, Westchester, and Bronx, Kings, and Richmond within New York City. Most of these counties have agencies similar to those described below.

***County Planning Departments***
The primary function of these departments is to provide technical assistance on planning and development matters to local governments. For example, county planning departments offer assistance, upon request, to other local governments relative to the formulation and enactment of local land-use controls, such as zoning ordinances, subdivision regulations, and special ordinances. The planning departments also provide assistance to local governments with regard to State and Federal regulatory programs. County land-use plans have been developed for all counties along the Hudson River. These plans examine socio-economic conditions, land-use and land-capability characteristics, and present land use goals, objectives, policies, and implementation strategies.

***County Soil and Water Conservation Districts (SWCDs)***
SWCDs have been established in several counties along the Hudson Estuary. The primary objective of the SWCD is the protection of natural resources in each county, specifically the protection of soil and water resources and the agricultural resources dependent on soil and water. The principal involvement of many of these SWCD districts has been the provision of technical assistance to concerned landowners regarding the establishment of appropriate erosion control measures.

***County Environmental Management Councils (EMCs)***
These bodies, established by the County and Regional Environmental Management Councils Act, are county-authorized citizen advisory boards. The primary responsibility of the EMC is to advise citizens and local government officials on matters affecting the management of the county's natural resources. The EMC provides resource information and technical assistance to local officials and county residents, conducts educational programs and special environmental projects and studies, and also helps local governments understand and comply with the requirements of state and federal environmental legislation. The EMC participates in the review of

development activities proposed within the county and provides comments on potential environmental impacts. The EMC at the request of county, town, or village officials reviews subdivision and development proposals to identify fragile natural resources and potential environmental impacts.

*County Health Departments*
The County Health Departments inspect sewage facilities to see that they conform with standards established by the State Department of Health in towns which have no local enforcement officer.

*Town Board*
The Town Board is a local legislative and executive body. Town Boards are responsible for the general management and control of town finances and have the power to acquire land for any public purpose. The Town Boards may also enact, amend, and repeal various ordinances, rules, and regulations, including a building code, vessel regulations, zoning ordinances, and subdivision regulations. City and village governments have executive bodies with functions similar to those of Town Boards.

*Planning and Zoning Boards*
Many towns have Planning and Zoning Boards which are advisory to the Town Board. These boards develop and administer zoning ordinances. Similar advisory entities exist in city and village governments.

## 5.3 Private Not-for-Profit Organizations

In addition to the various Federal, State, and local agencies which have roles and responsibilities affecting resource protection and management in the Hudson River Estuary, many private, non-profit organizations participate in management of the ecosystem. In consideration of the scope of this document, only the most prominent groups are described here, but many other resource-oriented groups are active in the Hudson River Valley.

### International and National Organizations

*The Nature Conservancy (TNC)*
The Nature Conservancy is an international conservation organization committed to the preservation of natural diversity by protecting lands and waters supporting the best examples of rare and endangered *elements* (plant and animal species or natural communities). TNC receives its funding from membership contributions, donations of land, grants, and corporate sources. Funds are used to protect and manage land where elements have been identified. Lands may be managed by TNC or transferred to an appropriate government agency. In New York, TNC has seven regional chapters, each of which administers local preserves and land acquisitions. The estuarine portion of the Hudson is contained in the Eastern New York Chapter including Albany, Rensselaer, Greene, and Columbia counties; and the Lower Hudson Chapter including Orange, Dutchess, Putnam, Rockland, Ulster and Westchester counties. TNC also works with the NY Natural Heritage Program to identify sites containing rare plants, animals, and communities on the Hudson.

*National Audubon Society*
The National Audubon Society is a national conservation group that provides leadership in scientific research, wildlife protection, conservation education, and environmental action. Audubon receives its funding from membership contributions, grants, and corporate sources. Funds are used to manage wildlife sanctuaries, maintain liaison with government agencies, prepare educational materials, and conduct scientific studies. National Audubon is headquartered in New York City, has a State office in Albany, and chapters throughout the state. Audubon currently manages two wildlife preserves along the Hudson River Estuary, at Ramshorn Marsh and at Constitution Island.

### State and Local Organizations

*Scenic Hudson*
Scenic Hudson is a community and environmental organization committed to preserving and restoring the ecological, scenic, historic, and recreational resources of the Hudson River and the Hudson Valley. Scenic Hudson receives its funding largely from foundations and individual donors with additional monies coming from corporate and government sources. Funds are used for land acquisition, monitoring development activities, restoring historic sites, environmental lobbying, and public education. Scenic Hudson is also involved in the Hudson River Greenway which is concerned with preserving the natural corridor from New York City to Troy. Scenic Hudson is located in Poughkeepsie and is active along the entire length of the Hudson River.

*Clearwater*
The Hudson River Sloop Clearwater Inc., is an environmental education and advocacy organization committed to the protection and enhancement of the Hudson River and other waterways throughout the State. Clearwater is largely supported by membership contributions and grants. Funds are used to operate the sailboat Clearwater, a 106 foot replica of the early Hudson River sloops, that is used primarily for environmental education purposes. Clearwater is also active in lobbying, and reviews and monitors issues connected with the environmental health of the River. In addition, Clearwater sponsors and promotes numerous activities along the riverfront to encourage its use by the public. Clearwater's main headquarters are in Poughkeepsie. There are several local branches of Clearwater along the River.

*The Hudson River Foundation*
The Hudson River Foundation supports scientific and public policy research, environmental education programs, and physical improvement programs on the Hudson River. The Foundation was established in 1981 as the result of an agreement between environmental groups, government agencies, and utility companies which resolved a long series of legal battles over the environmental impacts of power plants along the River. The settlement with the utility companies included the provision of a $12 million endowment for the Foundation which is used for the Hudson River Fund to sponsor scientific and educational programs. In addition, $1.5 million was given to the Foundation by the State for the Hudson River Improvement Fund which provides grants for projects stressing the public use and enjoyment of the River. The Hudson River Foundation also provides grants for graduate student fellowships studying the River and sponsors the Polgar Fellowship Program which provides summer research scholarships to graduate and undergraduate students studying wetlands along the River.

*Hudson Riverkeeper Fund/Hudson River Fisherman's Association (HRFA)*
The HRFA is a community group, which was initially formed in 1965, and is dedicated to protecting the public interest on the Hudson River. In 1983, the HRFA began the Hudson Riverkeeper Fund which sponsors a full time Riverkeeper to serve as the eyes and ears of the public on the River and in court. The Riverkeeper receives funding from membership donations and legal settlement awards, the most notable resulting from a settlement with Exxon Corporation for transporting and selling the public's Hudson River water to the Caribbean island of Aruba. Funds support a Riverkeeper position and are used to enforce and promote environmental laws and ecologically sound practices to protect the River's resources.

## Research Organizations

*Hudsonia*
Hudsonia is an organization which conducts biological and ecological research on different aspects of the Hudson River Valley. Recent studies include an evaluation of the contribution of the Hudson River's tributaries to the larval production of anadromous fish and a study of the life history of grass shrimp. Hudsonia is headquartered at the Bard College Field Station in Annandale-on-Hudson.

*Institute of Ecosystem Studies (IES)*
The IES is a research division of the New York Botanical Gardens and is located in Millbrook, NY. IES sponsors biological and ecological research on many different aspects of the Hudson River. Recent studies include an examination of zooplankton populations in the River and the development of a model for phytoplankton production in the River.

*University Programs*
Many local colleges and universities, including Bard College, Rensselaer Polytechnic Institute, State University of New York (several campuses), Cornell, Columbia, Farleigh-Dickenson, University of Delaware, Fordham, and Pace, sponsor research along the estuary or have faculty members researching various aspects of the Hudson.

### FURTHER READING
Additional information on the groups and agencies described above can be obtained by contacting the offices listed in Appendix D.

Chapter 6:

## SITE SPECIFIC INFORMATION

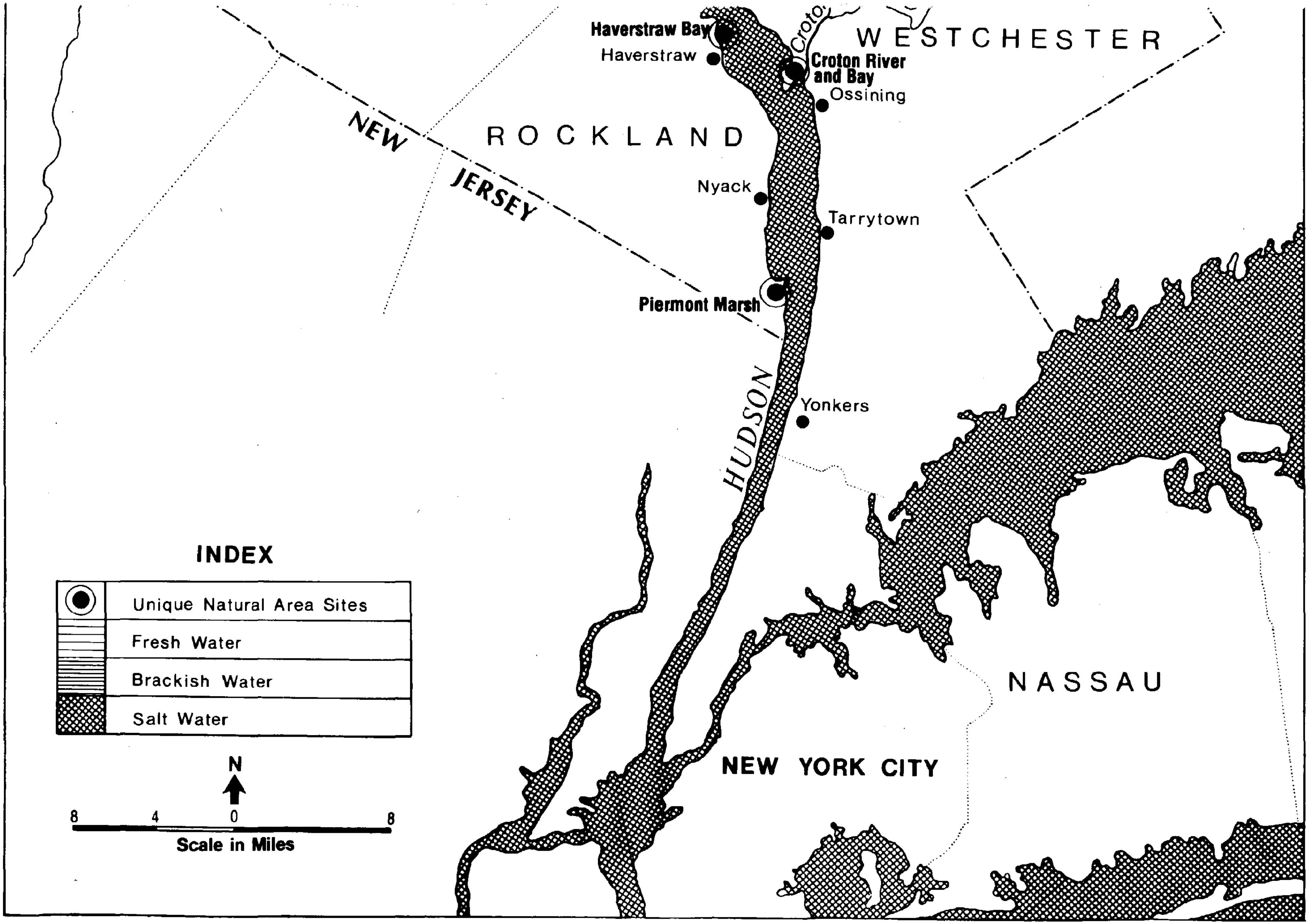
---

*In the preceding chapters, the natural and human components of the River ecosystem were examined as they apply to the tidal habitats as a whole. In this chapter, this general information is applied to 39 specific sites located along the River between Albany and New York City (see the Hudson River overview map). All portions of the River have value as habitat for plants and animals. The sites in this chapter, however, have been identified as having special importance and include 34 sites designated as Significant Coastal Fish and Wildlife Habitats under the State's Coastal Management Program and five additional sites recognized by the New York Natural Heritage Program as containing important plant and animal communities. As noted in the introduction to the guide, site-specific coverage is limited to the portion of the Hudson estuary north of the NYC municipal boundary.*

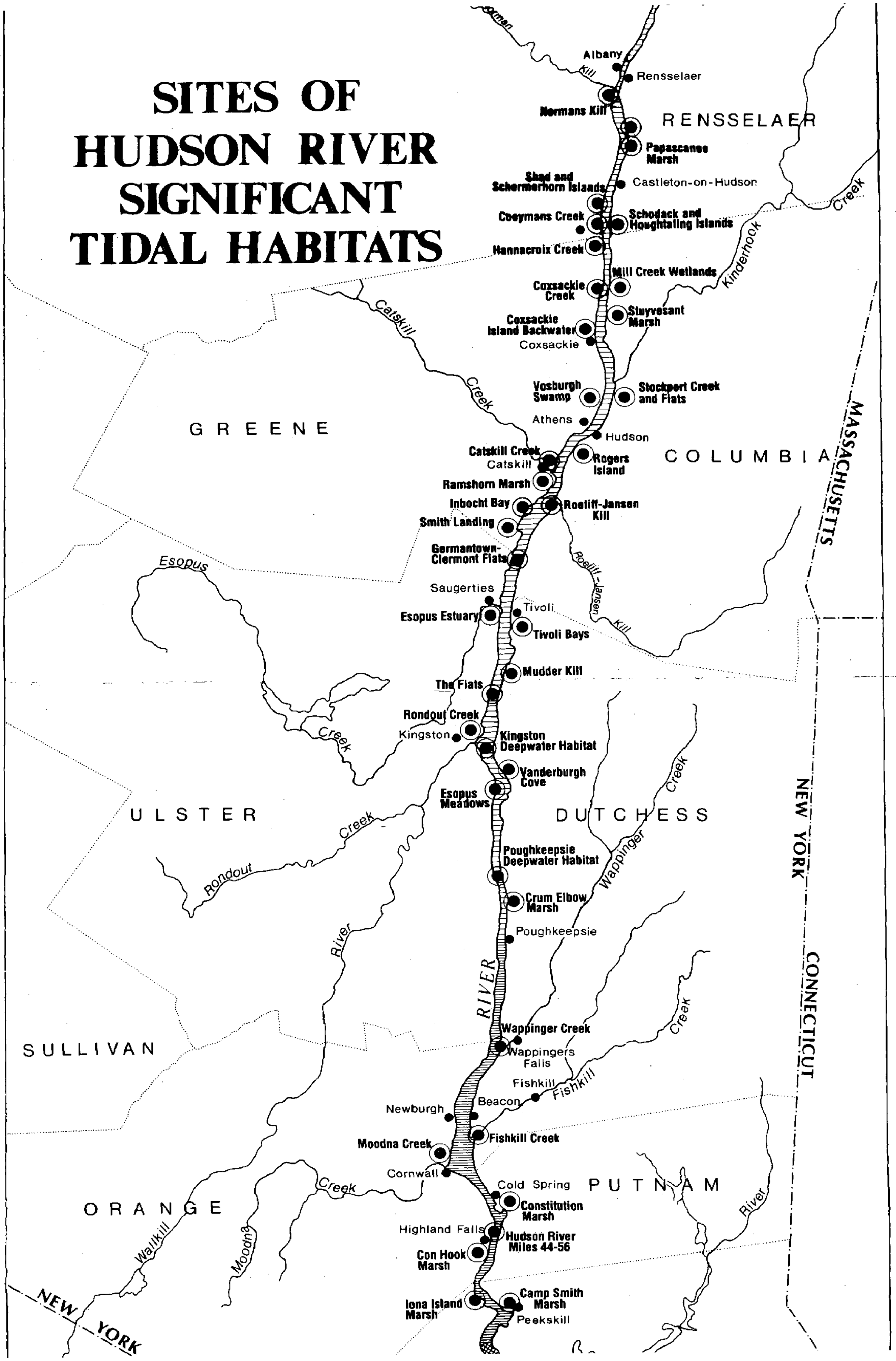
*Each site description consists of:*

- *Geographic information*
- *A description of significant biological features*
- *A description of human activities at the site*
- *Suggested habitat protection measures*
- *A map showing the boundaries of the site and important biological and cultural features*

---


WESTCHESTER
ROCKLAND
NEW JERSEY
NASSAU
NEW YORK CITY
HUDSON
Croton
Haverstraw Bay
Haverstraw
Croton River and Bay
Ossining
Nyack
Tarrytown
Piermont Marsh
Yonkers
INDEX
Unique Natural Area Sites
Fresh Water
Brackish Water
Salt Water
N
8 4 0 8
Scale in Miles

# SITES OF HUDSON RIVER SIGNIFICANT TIDAL HABITATS



# KEY TO SITE SPECIFIC INFORMATION

Information about each site is presented using a standardized format and map that identifies the locations of examples of natural and cultural features. The content of the standardized descriptions and the mapping symbols used to represent important features are explained in the following sections. The information regarding each site is not complete. Additional field work and evaluation is essential in assessing the potential impacts of any activities proposed at the sites.

Much of the information presented in this chapter is adapted from the Significant Coastal Fish and Wildlife Habitat narratives (DOS 1987). These original habitat narratives constitute the findings of the Secretary of State regarding the designation of each site and contain useful and more complete information regarding habitat value. These narratives are available through the Departments of State and Environmental Conservation, and local communities. Additional information comes from the New York State Natural Heritage Program's data files, the New York Field Office files of The Nature Conservancy, staff of the Coastal Management Program and local site-specific sources. Initial and subsequent field verifications were carried out for each site. All unattributed photgraphs in this chapter are by Nick Salafsky (TNC).

## GEOGRAPHIC INFORMATION

**Site Name:** The name used is the Coastal Management Program Significant Coastal Fish and Wildlife Habitat (CMP) name, unless otherwise noted.
**Town(s):** Lists towns containing or adjacent to the site.
**County(ies):** Identifies counties containing the site.
**7.5' Quad(s):** Name of the NYS DOT topographical map quadrangles in which the site appears. All maps shown are the latest in the DOT series, as of January 1989. Information shown on the base maps is not necessarily accurate since the base maps used to prepare the DOT maps may be several decades old and may no longer reflect current landforms and topography. The map accompanying each site narrative depicts the site boundaries, approximate locations of examples of significant biological and man-made features, and surrounding land use patterns. The maps are not complete. Evaluations of environmental impacts will require on site investigations.

## BIOLOGICAL FEATURES

**Community Types:** Lists the major communities found within the site (see Chapter 1 definitions). Single letter codes indicate where examples of each community type may be found. Refer to the code definition list for community types.

**Rare Species:** Lists endangered species known to use the area (see section 2.1). Animal habitat is not indicated on the map; use by a particular species should be presumed whenever suitable habitat exists.

**Valuable Species:** Lists the useful or commercially valuable fish and wildlife species using the habitat (refer to section 2.2).

**Size:** Gives the relative size *(small, medium, large, vast)* of the overall site as well as the size of each of the community types.

**Quality:** Gives a brief assessment of the relative quality of the site based on its diversity *(high, moderate, low, uniform)*, quality *(excellent, good, fair, poor)*, and degree of disturbance *(extensive, moderate, limited, none)*.

**Exotics :** Describes the degree to which exotic plants have invaded the site (see section 4.3). Large colonies of exotic plants are indicated on the site map with two letter codes. Refer to the list for code definitions. If a plant is listed without a map code, it can be presumed to be found in low concentrations throughout appropriate habitats.

**General Description:** A narrative describing the site, including photgraphs where available.

| Code | Community Type |
|---|---|
| D | deepwater |
| S | shallows |
| F | mud and sand flats |
| B | sandy beach |
| R | rocky shore |
| L | lower marsh |
| U | upper marsh |
| W | tidal swamp forest |
| C | freshwater creek |

COMMUNITY CODES

**Exotic Plants**

| | |
|---|---|
| **WC** | water chestnut |
| **CR** | common reed |
| **PL** | purple loosestrife |

**Major Features**

| | |
|---|---|
| **AR** | abandoned ruins |
| **BH** | bulkhead |
| **BL** | boat launch ramp |
| **BR** | bridge |
| **DA** | dam or barrier |
| **DB** | duck blind |
| **DR** | dredged reach |
| **DS** | dredge disposal site |
| **EL** | electric lines |
| **FJ** | flotsam and jetsam |
| **IN** | industrial building |
| **LF** | landfill or junkyard |
| **MA** | marina |
| **PI** | pier or causeway |
| **PK** | parking lot |
| **PP** | power plant |
| **RB** | RR bridge or culvert |
| **RS** | radio antenna or tower |
| **RV** | recreational vehicle trail |
| **SC** | shipping channel |
| **SP** | sewage plant |
| **TF** | tank farm |
| **TH** | seasonal residences |
| **WI** | water intake |

**Land Uses**

| | |
|---|---|
| **AG** | agriculture |
| **CP** | county park |
| **IN** | industry |
| **MR** | military reservation |
| **NA** | natural area |
| **PA** | picnic or camping area |
| **NH** | National Historic Site |
| **QU** | quarries |
| **RH** | residential housing |
| **TP** | town park |
| **SK** | state park |

FEATURE CODES

## HUMAN INTERACTIONS

**Major Features:** Lists the major man-made features present at the site (see Chapter 4). On the site map, two letter codes indicate the general location of the feature. Code definitions are provided in the list. Dredge reaches and dredge disposal sites also include numbered codes as listed by the US Army Corps of Engineers.

**Site History:** Describes the processes and actions that potentially influenced the current ecological system.

**Existing Use:** Describes the present use of the site. Institutions holding a SPDES permit (see section 4.3) in the early 1980's are also listed (Rohmann and Lilienthal, 1987).

**Surrounding Use:** Describes the current use of lands adjacent to the site. On the map, general land uses are indicated with a two letter code.

**Status:** Identifies the current protection available for the site as well as known ownership. State-mapped wetland codes are provided for general information only; concerns regarding regulated wetlands should be directed to the Department of Environmental Conservation. NY Natural Heritage Program sites included in the Significant Coastal Habitat area are also given.

## HABITAT PROTECTION MEASURES

**Site Boundary:** Indicates the relationship between the Significant Coastal Habitat boundary and the boundary depicted on the site map. Significant Coastal Habitat boundaries are shown as solid lines; other areas described are indicated by a dashed line. A description of the appropriate buffer zone is also given.

**Recommended Actions:** Describes actions needed to protect, restore or enhance the tidal habitats.

**Incompatible Use:** Describes potential future site and land uses that would be incompatible with maintaining the habitat values at present levels.

**Recommended Use:** Describes potential future site and land uses that would be compatible with or even beneficial to the tidal habitats.

**Knowledgeable Contacts:** Lists individuals knowledgeable about the specific site (see Appendix C for information on how to contact these individuals).

GEOGRAPHIC INFORMATION

REFER TO MAP NUMBER 1

**Site Name:** Normans Kill
**Town(s):** Albany, Bethlehem
**County(ies):** Albany
**7.5' Quad(s):** Albany, Delmar

BIOLOGICAL FEATURES

**Community Types:** Freshwater creek (C) with shallows (S) associated with the creek mouth.

**Rare Species:** None known.

**Valuable Species:** Important spawning area for anadromous fish including alewife, white perch and blueback herring. Large resident smallmouth bass population.

**Size:** Two miles of unobstructed creek extending to just downstream of the Thruway bridge. The lower mile is tidally-influenced. The creek drains over 170 square miles of land.

**Quality:** A *uniform* habitat of *fair* quality that has experienced *extensive* disturbance.

**Exotics:** The River banks near the mouth are covered with common reed (CR).

**General Description:** The lower tidally-influenced part of the site is referred to as "Island Creek" and is relatively deep with silt and clay substrate and muddy banks lined with common reed. The upper mile of the stream is fairly shallow with a gravelly substrate and steep wooded banks, largely in a natural condition.

*Figure 29: Norman's Kill looking east from Route 32. Photo by Bryan Swift/DEC*

## HUMAN INTERACTIONS

**Major Features:** Large tank farms (TF), many road and railroad crossings, bulkheading (BH), sewage plants (SP), power plant (PP), shipping channel (SC), dredging reaches (DR) 2 and 3, and a dredge disposal site (DS) U-25.

**Site History:** The River channel was first dredged between 1926 and 1930. Subsequent maintenance dredging occurred repeatedly. There are signs that the creek itself was also dredged at sometime in the past.

**Existing Use:** Bass fishing, water withdrawals from the upstream areas. SPDES waste discharge permits were held in the early 1980's by Mobil Oil, Pyramid Crossgates Shopping Center, Air Products and Chemicals, Exxon, Niagara Mohawk's Albany Steam Plant, Sears Petroleum Storage Terminal, and the Albany County and Albany City sewage districts.

**Surrounding Use:** Residential housing (RH), many industrial activities (IN), natural areas (NA), roads and railroads.

**Status:** Designated as a Significant Coastal Fish and Wildlife Habitat. Upstream lands under private ownership.

## HABITAT PROTECTION MEASURES

**Site Boundary:** Includes the entire Significant Coastal Fish and Wildlife area. The buffer zone should include the woodlands surrounding the creek and its tributaries at least to the crest of the adjacent bluffs.

**Recommended Actions:** Limit existing and additional upstream water withdrawals, especially during times of low water flow and during fish spawning, incubation and nursery periods (spring and summer). Monitor and control drainage to limit highway, tank farm, and industrial area runoff flowing into the creek. Maintain vegetation as a natural buffer.

**Incompatible Uses:** Discharge of sewage and other waste products into the stream, development of the creek bank and watershed leading to increased runoff, construction of dams and other barriers to fish movements. Clearing vegetation with subsequent erosion and soil slumping. Any activity resulting in introduction of sediment. Water withdrawals, particularly during low flow periods.

**Recommended Use:** Increased access for recreation fishing.

**Knowledgeable Contacts:** Tom Hart, DOS; DEC Region 4, Fisheries Manager or Environmental Protection Biologist.

GEOGRAPHIC INFORMATION

**Site Name:** Papscanee Marsh and Creek

REFER TO MAP NUMBER 1

**Town(s):** East Greenbush, Rensselaer
**County(ies):** Rensselaer
**7.5' Quad(s):** Delmar, East Greenbush

BIOLOGICAL FEATURES

**Community Types:** Largely comprised of upper marsh (U) with lesser amounts of shallows (S), mudflats (F), lower marsh (L), and freshwater creek (C).

**Rare Species:** Least bittern nesting area, reported map turtle population.

**Valuable Species:** Waterfowl use during migrations. Many breeding birds including green-backed heron, Virginia rail, several duck species, marsh wren, swamp sparrow, and others. Spawning and nursery grounds for anadromous and resident fish including American shad, blueback herring, alewife, white catfish, black bass and white perch.

**Size:** Small sections of shallows in Papscanee Creek and Moordener Kill. Small sections of lower marsh and mudflat in the creek. Large tract of upper marsh surrounding the creek.

**Quality:** A *moderately* diverse habitat of *fair* quality that has experienced *extensive* disturbance.

**Exotics:** Invasion of the upper marsh by common reed (CR) and purple loosestrife (PL).

**General Description:** The tidal portions of the site are along Papscanee Creek between the RR on the west and Route 9J on the east and along the first mile of Moordener Kill. Papscanee Creek is largely filled with lower marsh plants and is surrounded by large fields of reed-dominated upper marsh. Moordener Kill is a medium gradient warmwater stream with a gravelly substrate and some lower marsh vegetation. West of the RR is all non-tidal scrub forest.

*Figure 30: Wetland and shallows in backwater area at Papscanee Marsh*

## HUMAN INTERACTIONS

**Major Features:** Large industrial complexes (IN), recreational vehicle trails (RV), bulkheading along the River (BH), RR and highway rights of way surrounding the area, permanent residences (RH), radio antenna or towers (RS), dam (DA), power plant (PP), tank farms (TF), sewage plant (SP), shipping channel (SC), dredging reaches (DR) 9 and 11, dredge disposal sites (DS) U-1, U-2, U-8, U-10, and U-10A.

**Site History:** Bulkheading and fill in the 1800's connected Campbell Island to the mainland (see section 4.5). The River channel was first dredged between 1926 and 1930 with subsequent maintenance dredging and disposal. Direct agricultural use of the upper marsh including filling and draining.

**Existing Use:** Waterfowl hunting, trapping, fishing, and bird watching. SPDES waste discharge permits were held in the early 1980's by the Fort Orange Paper Company, and the Castleton-on-Hudson and Bethlehem sewage districts.

**Surrounding Use:** Residential houses (RH), industrial (IN), agricultural (AG), and natural areas (NA), Castleton and Rensselaer urban areas.

**Status & Ownership:** Designated as a Significant Coastal Fish and Wildlife Habitat. The area wholly or partially includes State-regulated freshwater wetlands (D-102, EG-1). Refer to the official wetland maps available in the Department of Environmental Conservation regional office.

## HABITAT PROTECTION MEASURES

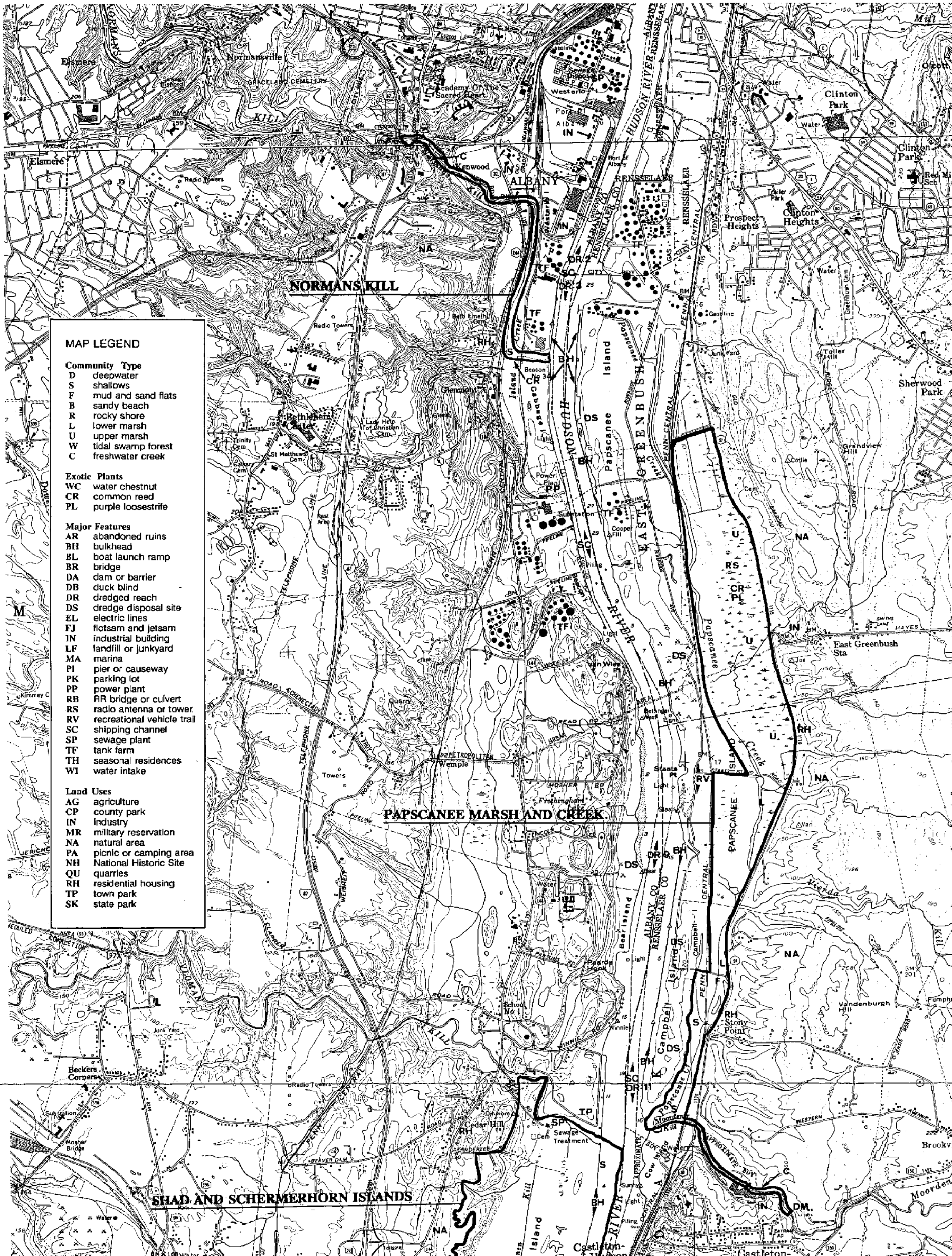
**Site Boundary:** Includes the entire Significant Coastal Fish and Wildlife Habitat area. Buffer zones should include the wooded areas along Papscanee Creek and the banks and bluffs along Moordener Kill.

**Recommended Actions:** Institute non-point pollution controls to reduce highway and industrial runoff. Manage agricultural uses to enhance wildlife uses. Restoration of upper marsh may be warranted, especially for waterfowl use.

**Incompatible Use:** Discharge of chemicals and other waste products into the stream, development of the watersheds surrounding the site that would result in increased runoff. Dredging either of the two creeks. Constructing additional bulkheads.

**Recommended Use:** Given the already disturbed nature of most of the upper marsh, the site may be suitable for use as a managed area for waterfowl and other birds by enhancing food sources and by providing protected open water areas. The site may also be suitable for providing recreational access to the main River channel and resource-related access to the wetlands from Campbell Island.

**Knowledgeable Contacts:** Tom Hart, DOS; DEC Region 4, Fisheries or Wildlife Manager or Environmental Protection Biologist.




**HUDSON RIVER TIDAL HABITATS** **MAP NUMBER 1**

**Normans Kill / Papscanee Marsh and Creek**

Miles

0 ½ 1

N

New York State Department of State Division of Coastal Resources and Waterfront Revitalization

Prepared by T. Hart and N. Salafsky December 1989

GEOGRAPHIC INFORMATION

**Site Name:** Shad and Schermerhorn Islands REFER TO MAP NUMBER 2
**Town(s):** Bethlehem, Coeymans
**County(ies):** Albany
**7.5' Quad(s):** Delmar

BIOLOGICAL FEATURES

**Community Types:** Largely comprised of shallows (S) and mudflats (F), with lesser amounts of lower marsh (L), upper marsh (U) and freshwater creek (C).

**Rare Species:** Heart leaf plantain historical record, estuary beggar-ticks.

**Valuable Species:** Large feeding areas for herons and other wading birds, furbearers, deer and other upland game, limited waterfowl usage, important spawning and nursery grounds for American shad, blueback herring, alewife, white perch, striped bass and resident fish species.

**Size:** Large shallows and mudflats zone, medium sized marsh areas, several miles of tidal creek along Binnen and Vloman Kills draining 30 square miles. The entire area constitutes a large, undeveloped flood plain ecosystem.

**Quality:** A *moderately* diverse habitat of *good* quality that has experienced *limited* disturbance.

**Exotics:** Limited patches of purple loosestrife (PL) along the fringes of Binnen Kill.

**General Description:** The tidal portions of this site are dominated by shallows and mudflats between the islands and the River. A grassy marsh and sand/mud flats are located at a break in the bulkheads along the east side of the island. A shallows, mudflat, and lower marsh area is associated with the mouth of Binnen Kill, and very limited mudflats areas are located along Vloman Kill. The center of the island is largely upland forest and open agricultural areas.

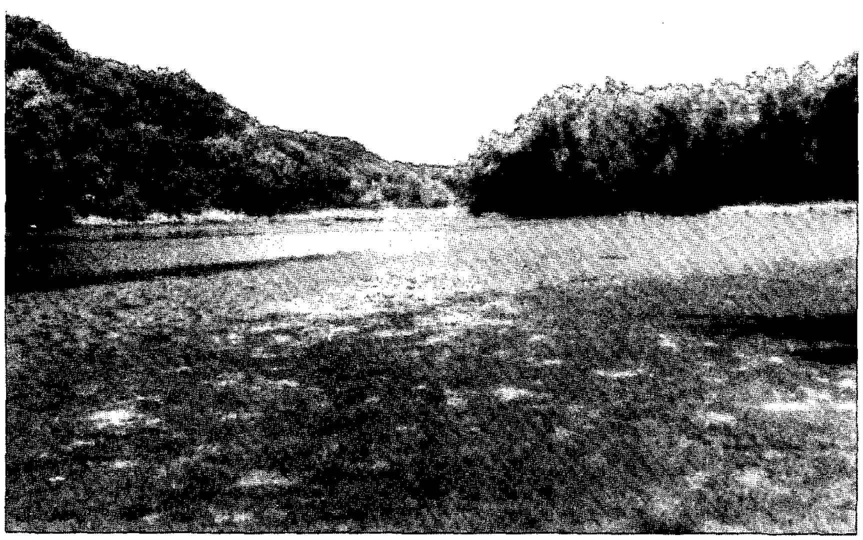


*Figure 31: At the mouth of the Binnen Kill, looking north*

## HUMAN INTERACTIONS

**Major Features:** Bulkheads (BH) on the River side, hunting cabins (TH), recreational vehicle and dirt roads (RV), Thruway and railroad bridges (RB), agricultural fields (AG), sewage treatment plant (SP), gravel pit (QU), marina (MA), shipping channel (SC), dredging reaches (DR) 11, 12, and 14, dredge disposal (DS) site U-7.

**Site History:** Bulkheading and fill in the 1800's connected Shad Island to the mainland (see section 4.5). The River channel was first dredged between 1926 and 1930 with subsequent maintenance dredging and disposal occurring on the islands.

**Existing Use:** Significant deer and waterfowl hunting, fishing, boating, and agricultural use. SPDES waste discharge permits were held in the early 1980's by the Castleton-on-Hudson and Bethlehem sewage districts.

**Surrounding Use:** The island is fairly isolated by steep bluffs. Limited residential housing (RH), agricultural (AG), and natural areas (NA) border the site.

**Status:** Designated as a Significant Coastal Fish and Wildlife Habitat. Much of the island is privately owned. The site includes the Natural Heritage Program's Shad and Schermerhorn Islands site.

## HABITAT PROTECTION MEASURES

**Site Boundary:** Includes the entire Significant Coastal Fish and Wildlife Habitat area. The buffer zone should include the upland woods on the west side to the crest of the bluff, the watershed of Vloman Kill, and upland portions of the islands.

**Recommended Actions:** Study effects of removing bulkheads to enhance water flow along the east shore of the island in order to promote wetland expansion. Monitor drainage patterns to determine if runoff from the Thruway overpass and agricultural lands is entering the habitat. Remove unsightly abandoned cabins from the east side of the island. Institute soil conservation practices in agricultural areas. Explore use of conservation easements with private landowners to protect natural condition of islands.

**Incompatible Use:** Dredging or bulkheading shallows and mudflats. Construction of barriers to fish movements in both Vloman and Binnen Kills. Development that would result in increased sedimentation, particularly clearing vegetation and expanding agricultural areas without using soil conservation practices. Channelization or other means of reducing flooding in wetland areas.

**Recommended Use:** Managed game area, continued low-intensity recreation.

**Knowledgeable Contacts:** Tom Hart, DOS; DEC Region 4, Fisheries or Wildlife Manager or Environmental Protection Biologist.

## GEOGRAPHIC INFORMATION

**Site Name:** Schodack and Houghtaling Islands and Schodack Creek — REFER TO MAP NUMBER 2
**Town(s):** Schodack, Stuyvesant, New Baltimore
**County(ies):** Rensselaer, Columbia, Greene
**7.5' Quad(s):** Delmar, Ravena

## BIOLOGICAL FEATURES

**Community Types:** Predominantly shallows (S), mudflats (F), and sandy beach (B), with lesser amounts of lower marsh (L) and upper marsh (U).

**Rare Species:** Osprey roosting and feeding areas on lower Schodack Island, heart leaf plantain historical record, possible use by shortnose sturgeon.

**Valuable Species:** Waterfowl use during migrations and limited nesting activity, nesting by other bird species. Furbearers present. Schodack Creek provides important spawning and nursery grounds for American shad, white perch, alewife, and blueback herring; black bass and other freshwater fish species. Northernmost concentration of shad spawning on the Hudson.

**Size:** Large total area of shallows and mudflats, medium sized lower and upper marsh, long stretches of sandy beach shore.

**Quality:** A *high* diversity habitat of *excellent* quality that has experienced *limited* disturbance.

**Exotics:** Moderate to severe invasion of purple loosestrife (PL) and common reed (CR) in the upper marsh areas in the north part of the site.

**General Description:** The tidal portions of this site are centered on a large area of shallows and mudflats running the length of Schodack Creek. The creek is a relic side channel of the Hudson that now functions as a backwater area with generally higher biological productivity than the River. The creek is flanked on both sides by lower marsh that is broader in several locations including the Rensselaer-Columbia county line, Hell Gate, and just north of the Thruway bridge. Thin strips of bulrush-dominated, sandy shore are found along the southern-most sides of the creek and an area of upper marsh is located between the creek and Route 9J at the northern part of the site. The center of the island is largely scrubby upland forest and open agricultural areas.

*Figure 32: Looking across Schodack Creek at Schodack Island*

## HUMAN INTERACTIONS

**Major Features:** Bulkheads on the River side (BH), recreational vehicle trails (RV), Thruway and railroad overpasses (RB), RR track forms east boundary of the site, shipping channel (SC), marina (MA), dredging reaches (DR) 14, 17, 18, and 22, dredge disposal (DS) sites U-3A, 6, 18, 20, and 21.

**Site History:** Site of Mohican Indian council fires and main village. Bulkheading and fill in the 1800's connected Upper and Lower Schodack and Houghtaling Islands to the mainland (see section 4.5). The River channel was first dredged between 1926 and 1930 with subsequent maintenance dredging and disposal.

**Existing Use:** Deer and waterfowl hunting, bird watching, trapping, and commercial shad fishing.

**Surrounding Use:** The islands are relatively isolated by the creek and the railroad. Agricultural areas (AG), residential houses (RH), and the Villages of Castleton and Schodack Landing occur on the eastern shore of the River.

**Status:** Designated as a Significant Coastal Fish and Wildlife Habitat. Much of the Island is within the Castleton Island State Park, an undeveloped State-owned property administered by the NYS Office of Parks, Recreation, and Historic Preservation. The area includes or partially includes State-regulated freshwater wetlands (R-201, R-202). Refer to the official wetland maps available in the Department of Environmental Conservation regional office. The area includes the Natural Heritage Program's Hellgate Marsh and Houghtaling Island Marsh sites.

## HABITAT PROTECTION MEASURES

**Site Boundary:** Includes the entire Significant Coastal Fish and Wildlife Habitat area. The buffer zone should include the watershed surrounding Muitzes Kill, extending to the bluff crest east of Route 9J.

**Recommended Actions:** Monitor and control drainage from the Thruway overpass and from Route 9J to limit runoff into the habitat. Contain waste resulting from bridge maintenance such as from paint and scrapings. Develop a park plan which will actively protect Schodack Creek and most of the southern sections of the islands. Evaluate re-establishment of channels between Houghtaling, Lower Schodack and Upper Schodack Islands to increase flows in Schodack Creek in order to halt succession in the backwater at its currently productive state and to isolate the Islands from existing human use impacts.

**Incompatible Use:** Wetland creation in existing productive shallows areas, development of the uplands in the southern part of the island near the osprey sites, dredging, development or construction activity in or along Schodack Creek that is not specifically designed for habitat enhancement. Clearing vegetation from islands and adjacent bluffs. Dredge disposal at designated sites is compatible provided that entry of sediment into adjacent waters is minimized.

**Recommended Use:** Development of the northern island as a camping site or day use park. Boating facilities along bulkheaded shoreline of Upper Schodack Island. Either eliminate or formalize existing recreational vehicle use to minimize environmental damage. Construction of nature and hiking trails.

**Knowledgeable Contacts:** Tom Hart, DOS; DEC Region 4, Fisheries or Wildlife Manager or Environmental Protection Biologist.

GEOGRAPHIC INFORMATION

**Site Name:** Coeymans Creek
**Town(s):** Coeymans
**County(ies):** Albany
**7.5' Quad(s):** Ravena

REFER TO MAP NUMBER 2

BIOLOGICAL FEATURES

**Community Types:** Predominantly shallows (S) with smaller amounts of mudflats (F), lower marsh (L), upper marsh (U), and swamp forest (W).

**Rare Species:** None known.

**Valuable Species:** Important spawning area for anadromous fishes including alewife, blueback herring, white perch, and American shad. Limited waterfowl use during migrations.

**Size:** One-quarter of a mile of creek extending up to the large falls below Route 144. A large shallows area near the creek mouth in the River, small patches of marsh along the shore, and a very small piece of swamp forest.

**Quality:** A *low* diversity habitat of *fair* quality that has experienced *moderate* disturbance.

**Exotics:** Invasion by purple loosestrife (PL) into the upper marsh areas.

**General Description:** The site consists of a tidal cove at the mouth of Coeymans Creek, shallows along the shoreline, and a small marsh area south of the creek that has restricted tidal flow due to bulkheading.

*Figure 33: Bulkhead across backwater north of marina near Coeymans Creek. Photo by Bryan Swift/DEC*

## HUMAN INTERACTIONS

**Major Features:** Bulkheading and diking (BH), a town park (TP), a large marina (MA), sewage treatment plant (SP), residential housing (RH), dam (DA), shipping channel (SC), dredging reaches (DR) 17 and 18.

**Site History:** The bulkheads were constructed in the mid-19th century.

**Existing Use:** Limited waterfowl hunting and fishing, recreational boating. SPDES waste discharge permits were held in the early 1980's by Atlantic Cement, Callanan Industries, Consolidated Rail Corporation, and the local sewage treatment district.

**Surrounding Use:** Village of Coeymans, residential housing (RH), and natural areas (NA).

**Status:** Designated as a Significant Coastal Fish and Wildlife Habitat. The area includes or partially includes State-regulated freshwater wetlands (R-16). Refer to the official wetland maps available in the Department of Environmental Conservation regional office.

## HABITAT PROTECTION MEASURES

**Site Boundary:** Includes the entire Significant Coastal Fish and Wildlife Habitat area. The buffer zone should contain the fields and woods west of the site to Route 144 as well as the immediate areas bordering the creek.

**Recommended Actions:** Evaluate selective removal of bulkhead along the edge of the marsh in order to enhance tidal flow and possibly promote marsh expansion and inhibit purple loosestrife growth. Monitor and control runoff entering from the marina and the surrounding roads.

**Incompatible Use:** Construction of dams and other barriers to fish movements, dredging shallow areas, development of the watersheds near the marsh and the creek that would result in increased runoff and soil erosion. Elimination of natural vegetative buffer.

**Recommended Use:** Town riverside park, boat launch near the marina.

**Knowledgeable Contacts:** Tom Hart, DOS; DEC Region 4, Fisheries or Wildlife Manager or Environmental Protection Biologist.

GEOGRAPHIC INFORMATION

**Site Name:** Hannacroix Creek

REFER TO MAP NUMBER 2

**Town(s):** Coeymans, New Baltimore
**County(ies):** Albany, Greene
**7.5' Quad(s):** Ravena

BIOLOGICAL FEATURES

**Community Types:** Predominantly freshwater creek (C) with shallows (S), mudflats (F), lower marsh (L), upper marsh (U), and swamp forest (W) associated with the creek mouth.

**Rare Species:** None known.

**Valuable Species:** Important spawning area for alewife, blueback herring, white perch, American shad, and other fishes. Resting and feeding areas for migratory waterfowl. Feeding areas for herons, various birds, and furbearing mammals.

**Size:** Medium sized shallows and mudflats areas, medium sized marsh areas, medium sized tidal swamp forest. Tidal zone of the creek extends to Route 144, with about 1.5 miles of unobstructed fish habitat.

**Quality:** A *moderate* diversity habitat of *excellent* quality that has experienced *limited* disturbance.

**Exotics:** Limited invasion of the upper marsh and creek banks by purple loosestrife (PL) and common reed (CR).

**General Description:** The site consists of shallows and mudflats along the River shore and in the tidal portion of the creek. Hannacroix Creek is a medium gradient, perennially warmwater stream with a gravel and rock substrate which drains an area in excess of 60 square miles. There is a small area of lower and upper marsh along the River in front of a tidal swamp forest that extends back to Route 144.

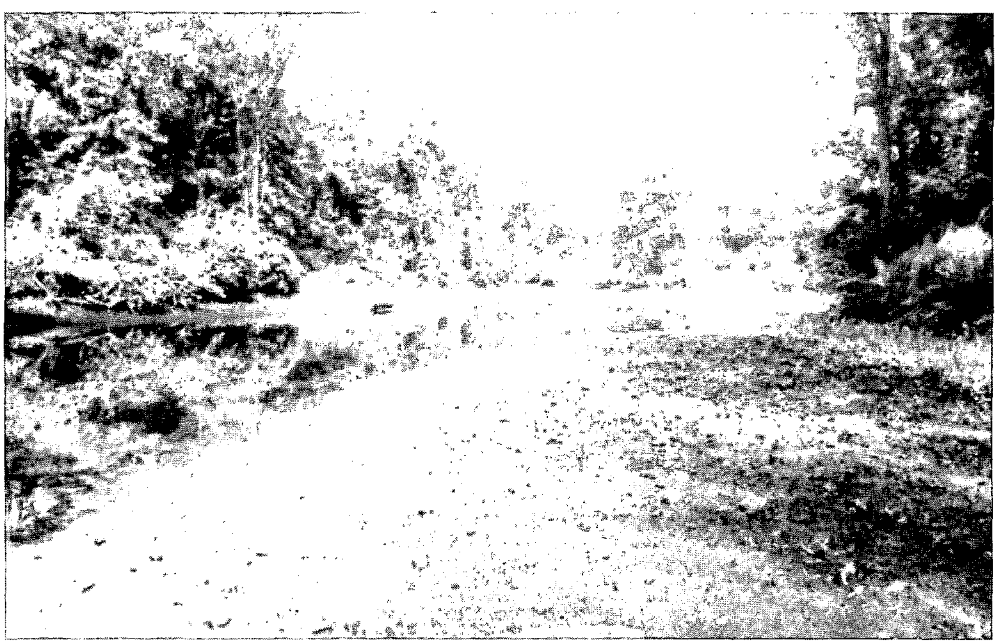


*Figure 34: Hannacroix Creek below Route 144. Photo by Bryan Swift/DEC*

## HUMAN INTERACTIONS

**Major Features:** Sewage plant (SP) discharging effluent into the creek, bulkheads (BH), vehicle trails (RV) mowed through vegetation, shipping channel (SC), dredging reach (DR) 18.

**Site History:** The River channel was first dredged between 1926 and 1930 with subsequent maintenance dredging.

**Current Use:** Limited waterfowl hunting and fishing. A SPDES waste discharge permit was held in the early 1980's by the local municipal sewage district.

**Surrounding Use:** Natural areas (NA), residential housing (RH).

**Status:** Designated as a Significant Coastal Fish and Wildlife Habitat. Parts of the swamp forest are privately owned and were for sale as of September 1988. The area wholly or partially includes State-regulated freshwater wetlands (R-16). Refer to the official wetland maps available in the Department of Environmental Conservation regional office. The site includes the Natural Heritage Program's Hannacroix Creek Mouth site.

## HABITAT PROTECTION MEASURES

**Site Boundary:** Includes the entire Significant Coastal Fish and Wildlife Habitat area, plus the area identified as swamp forest extending back to Route 144 (dashed line). The buffer zone should include the wooded uplands surrounding Hannacroix Creek and extending to the crest of the steep banks.

**Recommended Actions:** Monitor and control runoff entering the habitat from Route 144. Implement a watershed management program to maintain forested creek corridor, and limit agricultural runoff.

**Incompatible Use:** Development or dredging of the shallows and mudflats, development of the Hannacroix Creek watershed area resulting in increased runoff. Bulkheading or dredging in the creek. Marina development. Clearing vegetation on adjacent bluffs.

**Recommended Use:** Increased fishing access.

**Knowledgeable Contacts:** Tom Hart, DOS; DEC Region 4, Fisheries or Wildlife Manager or Environmental Protection Biologist.

GEOGRAPHIC INFORMATION

**Site Name:** Mill Creek Wetlands — REFER TO MAP NUMBER 2
**Town(s):** Stuyvesant
**County(ies):** Columbia
**7.5' Quad(s):** Ravena

BIOLOGICAL FEATURES

**Community Types:** Predominantly swamp forest (W) with smaller amounts of shallows (S), mudflats (F), sandy beach (B), lower marsh (L), and upper marsh (U).

**Rare Species:** Estuary beggar-ticks.

**Valuable Species:** Limited waterfowl use during migrations. Populations of breeding birds including green-backed herons, various ducks, and many passerine birds.

**Size:** Medium to large swamp forest (the smallest of four sizeable tidal swamps on the Hudson). Small upper and lower marsh areas, small to medium sandy beach, mudflats, and shallows.

**Quality:** A *high* diversity habitat of *good* quality that has experienced *moderate* disturbance.

**Exotics:** Limited invasion of purple loosestrife (PL) and common reed (CR) in the upper marsh and along the sandy beach.

**General Description:** Most of the site is a large tidal swamp forest located between Route 9J and the railroad. The swamp is fed by streams flowing from the uplands to the east and two channels under the RR to the River on the west. The land directly between the RR and the River is non-tidal upland with a stretch of tidal sandy beach along the front. The northern part of the site includes a small lower marsh at the mouth of a small stream, which is backed by a small upper marsh area.

*Figure 35: Mill Creek and swamp forest above the railroad bridge. Photo by Bryan Swift/DEC*

## HUMAN INTERACTIONS

**Major Features:** RR tracks with several bridges (RB) over tributary streams, small marina (MA) and picnic area (PA), high bluff with erosion possibly induced by boat wakes, shipping channel (SC), bulkheads (BH), dredging reaches (DR) 23 and 24.

**Site History:** Development of the swamp forest was possibly enhanced by the construction of the RR in the 1850's which limited tidal inflow and may have allowed succession to reach the current stage. The River channel was first dredged between 1926 and 1930 with subsequent maintenance dredging and disposal.

**Existing Use:** Limited hunting, fishing, trapping, and bird watching.

**Surrounding Use:** Residential housing (RH), railroad and highway corridors, natural areas (NA).

**Status & Ownership:** Designated as a Significant Coastal Fish and Wildlife Habitat. Site is privately owned with portions recently acquired by The Nature Conservancy. The area includes or partially includes State-regulated freshwater wetlands (R-202). Refer to the official wetland maps available in the Department of Environmental Conservation regional office. The site includes the Natural Heritage Program's Mill Creek Marsh site.

## HABITAT PROTECTION MEASURES

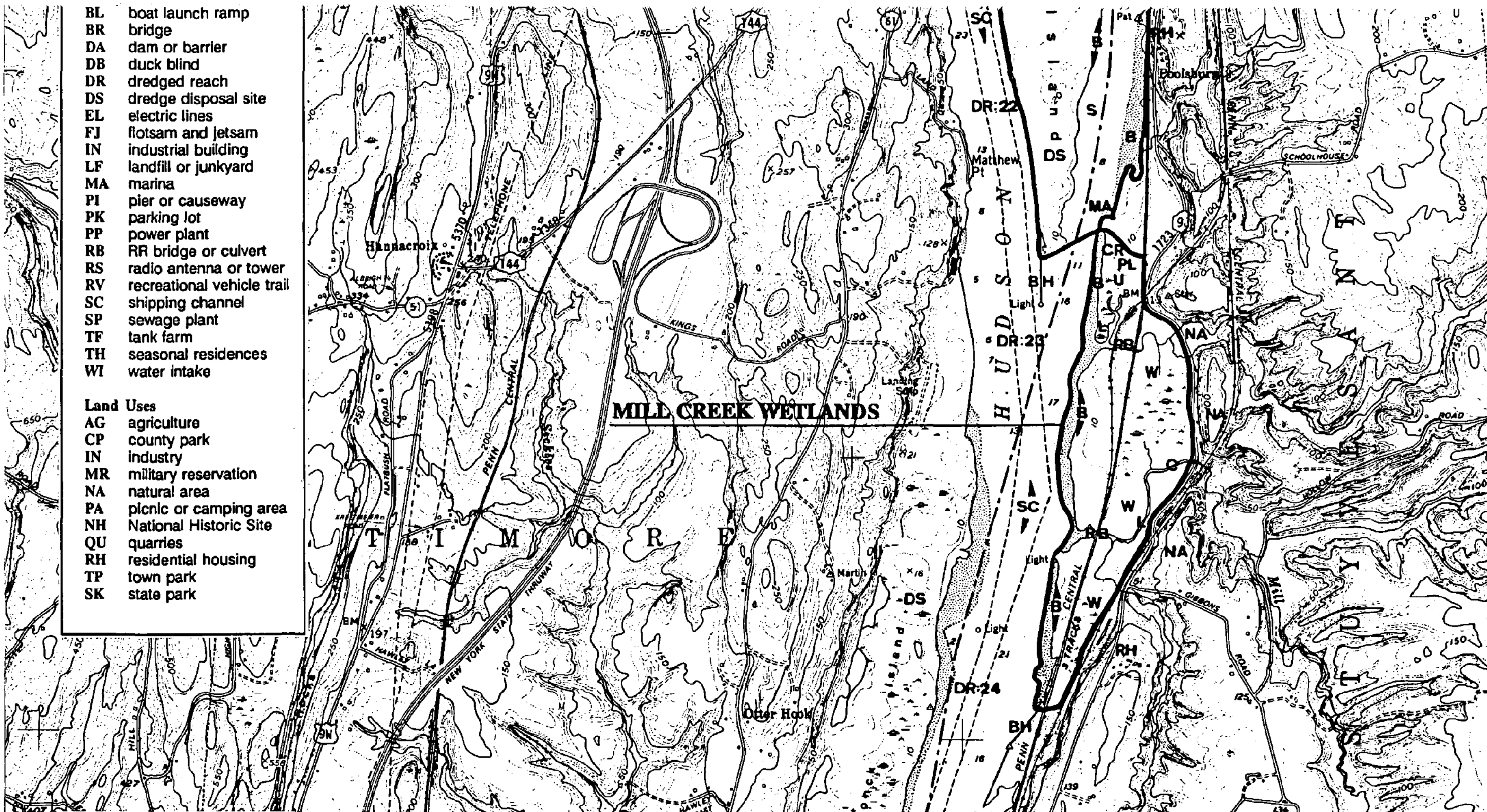
**Site Boundary:** Includes the entire Significant Coastal Fish and Wildlife Habitat area. The buffer zone should include the upland forest to the east and bluffs to approximately the 100 foot contour.

**Recommended Actions:** Monitor effects of boat wakes on the eroding bluff area (erosion may actually be beneficial to the estuary beggar-ticks population). Maximize protective ownership to preserve swamp habitat. Enhance tidal flow into the upper marsh area to inhibit further spread of loosestrife and reed. Monitor and minimize herbicides applied along the RR rights of way to limit their entry into the habitat. Institute a watershed management plan for Mill Creek. Monitor and control runoff from Route 9J.

**Incompatible Use:** Activities that would subdivide, destroy, or alter the tidal swamp forest habitat. Activities that would threaten the sandy beach area where the beggar-ticks grows. Construction of barriers to water flow and fish movement in Mill Creek and the creek to the north. Clearing vegetation within the immediate watershed.

**Recommended Use:** The upland between the River and the RR track could be developed for use as a picnic site if adverse impacts on the beach could be averted. Managed access to the swamp forest for education could be provided with boardwalks.

**Knowledgeable Contacts:** Tom Hart, DOS; DEC Region 4, Fisheries or Wildlife Manager or Environmental Protection Biologist. Robert Zaremba, The Nature Conservancy.




# HUDSON RIVER TIDAL HABITATS MAP NUMBER 2

## Shad and Schermerhorn Islands / Schodack and Houghtaling Islands and Schodack Creek / Coeymans Creek / Hannacroix Creek / Mill Creek Wetlands

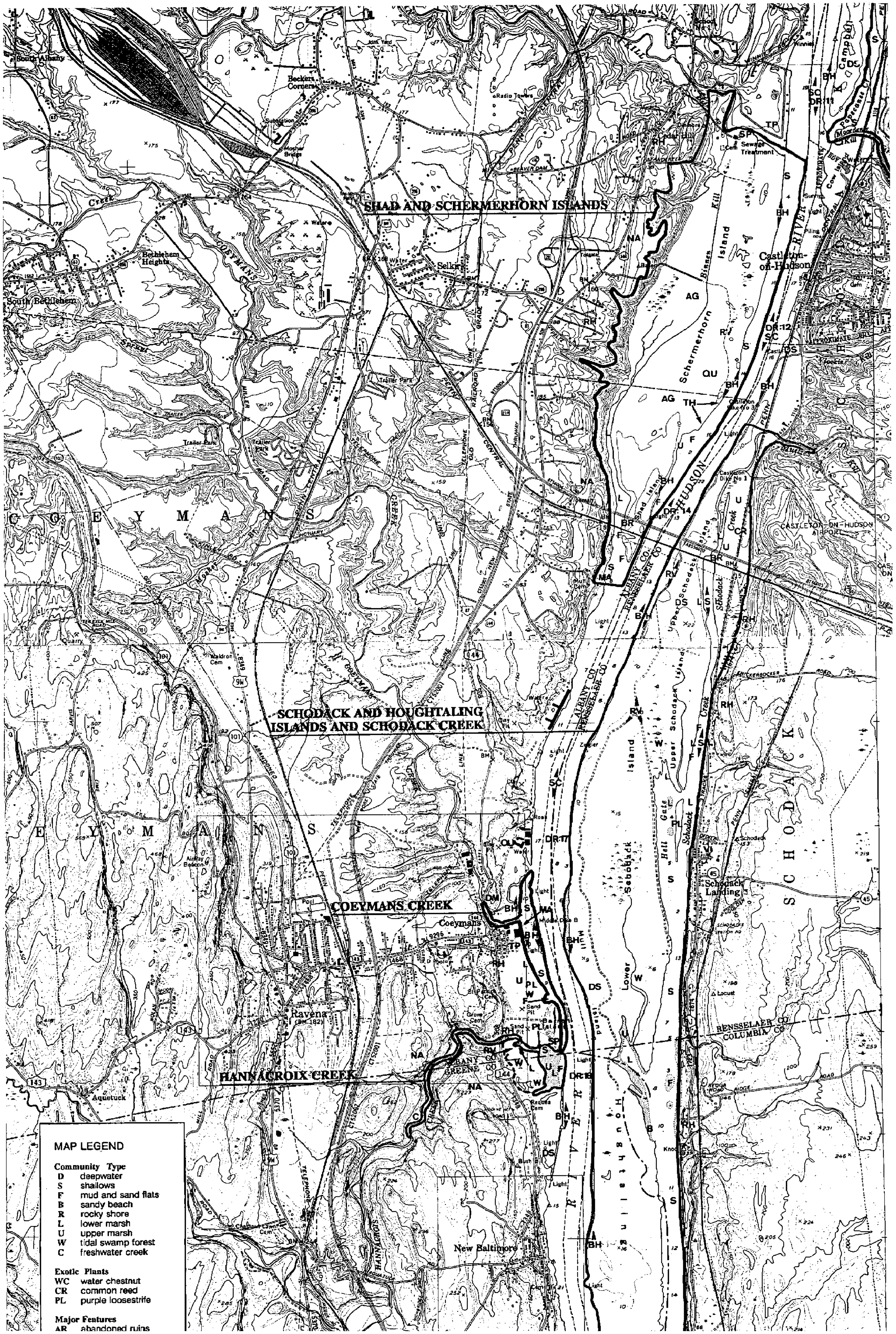
Miles

0 ½ 1

N

New York State Department of State Division of Coastal Resources and Waterfront Revitalization

Prepared by T. Hart and N. Salafsky December 1989


SHAD AND SCHERMERHORN ISLANDS
SCHODACK AND HOUGHTALING ISLANDS AND SCHODACK CREEK
COEYMANS CREEK
HANNACROIX CREEK
COEYMANS
SCHODACK
HUDSON RIVER
Castleton-on-Hudson
Coeymans
Ravena
New Baltimore
Schodack Landing
Selkirk
South Bethlehem
Bethlehem Heights
Beckers Corners
South Albany
Aquetuck
ALBANY CO
RENSSELAER CO
GREENE CO
COLUMBIA CO
MAP LEGEND
Community Type
D deepwater
S shallows
F mud and sand flats
B sandy beach
R rocky shore
L lower marsh
U upper marsh
W tidal swamp forest
C freshwater creek
Exotic Plants
WC water chestnut
CR common reed
PL purple loosestrife
Major Features
AR abandoned ruins

GEOGRAPHIC INFORMATION

**Site Name:** Stuyvesant Marshes
**Town(s):** Stuyvesant
**County(ies):** Columbia
**7.5' Quad(s):** Ravena

REFER TO MAP NUMBER 3

BIOLOGICAL FEATURES

**Community Types:** Roughly equal amounts of shallows (S), mudflats (F), sandy beach (B), rocky shore (R), lower marsh (L), and upper marsh (U).

**Rare Species:** Heart leaf plantain, kidney leaf mud-plantain.

**Valuable Species:** Limited use by migrating waterfowl, probable heavy use by various nesting bird species.

**Size:** Small to medium sized shallows, mudflats, and marsh areas, long stretch of sandy beach and rocky shore.

**Quality:** A *moderate* diversity habitat of *good* quality that has experienced *moderate* disturbance.

**Exotics:** Moderate to heavy invasion by common reed (CR), purple loosestrife (PL), and water chestnut (WC).

**General Description:** Although this site is fairly small, it contains many habitat types including a mix of upper and lower marsh west of the RR tracks, sand and mudflats at the mouth of a small stream, and a long stretch of sandy beach south of the stream, and a stretch of rocky shore along the River at the northern end of the site.

*Figure 36: Creek mouth at Stuyvesant Marshes*

## HUMAN INTERACTIONS

**Major Features:** RR track forms east boundary of site, small summer house on site (TH), limited bulkheading along the shore (BH), shipping channel (SC), dredging reaches (DR) 25, 26, and 27, dredge disposal (DS) areas U-23 and 24.

**Site History:** The River channel was first dredged between 1926 and 1930 with subsequent maintenance dredging and on site disposal. Limited disturbance from construction of RR.

**Existing Use:** Possible limited fishing and bird watching.

**Surrounding Use:** RR track, residential housing (RH), Village of Stuyvesant.

**Status & Ownership:** Not a designated Significant Coastal Fish and Wildlife Habitat. Recognized by the NY Natural Heritage program as containing tidal communities of moderate significance.

## HABITAT PROTECTION MEASURES

**Site Boundary:** Site boundaries shown on the map are from NY Natural Heritage Program. The buffer zone should include the upland watershed to the east including the bluffs extending to the 150 foot contour.

**Recommended Actions:** Monitor and control runoff entering the habitat from Route 9J and the RR. Monitor the heart leaf plantain for evidence of trampling or degradation; use protective fencing as appropriate.

**Incompatible Use:** Development, dredging, and filling of the wetland areas. Construction of new bulkheads along the shore. Clearing vegetation in the immediate watershed. Use of herbicides near rare plants.

**Recommended Use:** Educational opportunities are facilitated by the site's small size, accessibility, and large numbers of community types.

**Knowledgeable Contacts:** Tom Hart, DOS; DEC Region 4, Fisheries or Wildlife Manager or Environmental Protection Biologist. Carol Reschke, Robert Zaremba, Caryl DeVries and Kate Hubbs (The Nature Conservancy).

GEOGRAPHIC INFORMATION

**Site Name:** Coxsackie Creek
**Town(s):** New Baltimore
**County(ies):** Greene
**7.5' Quad(s):** Ravena

REFER TO MAP NUMBER 3

BIOLOGICAL FEATURES

**Community Types:** Principally freshwater creek (C) with lesser amounts of shallows (S), mudflats (F), sandy beach (B), lower marsh (L), upper marsh (U), freshwater creek (C).

**Rare Species:** Estuary beggar-ticks.

**Valuable Species:** Spawning habitat for alewife, blueback herring, white perch, and American shad. Feeding grounds for herons and other wading birds. Small mammal and furbearer foraging.

**Size:** Medium sized marsh, mudflats, and shallow littoral areas. One and a half miles of unobstructed stream accessible to migratory fish.

**Quality:** A *moderate* diversity habitat of *good* quality that has experienced *limited* disturbance.

**Exotics:** Limited purple loosestrife (PL) around the fringes of the marsh.

**General Description:** The mouth of the creek contains upper and lower marsh as well as mudflats. North of the creek mouth along the River is a spit of sandy shore (probably dredge material). The first half mile of creek is tidally influenced with a mud substrate while the next mile is non-tidal with a gravel and rock substrate. The marsh and creek are bordered by steep, wooded hills. Generally an undeveloped habitat.

*Figure 37: Tidal portion of Coxsackie Creek, looking east*

## HUMAN INTERACTIONS

**Major Features:** Residential housing (RH), highway, shipping channel (SC), dredging reach (DR) 25, dredge disposal (DS) site U-3.

**Site History:** The River channel was first dredged between 1926 and 1930 with subsequent maintenance dredging and disposal.

**Existing Use:** Limited fishing and hunting in the area. Local dip-net blueback herring fishery in the spring.

**Surrounding Use:** Agricultural lands (AG), natural areas (NA).

**Status & Ownership:** Designated as a Significant Coastal Fish and Wildlife Habitat. The site includes the Natural Heritage Program's Coxsackie Creek Mouth site.

## HABITAT PROTECTION MEASURES

**Site Boundary:** Includes the entire Significant Coastal Fish and Wildlife Habitat area. The buffer zone should include the woodlands west of the site and along the creek, including steep banks up to the 100 foot contour.

**Recommended Actions:** Monitor impact of runoff from the highway and surrounding agricultural areas. The creek has a very low concentration of water chestnut; it may be practical to use mechanical means to control the spread of this exotic here.

**Incompatible Use:** Future dredge disposal in or directly adjacent to the habitats. Dredging or construction in the stream. Clearing vegetation. Expanding agricultural use without adequate runoff control. Alterations to the current natural state of the creek corridor. Activities that would increase turbidity or temperature.

**Recommended Use:** The site is generally inaccessible from land. Fishing opportunities could be developed from River access points.

**Knowledgeable Contacts:** Tom Hart, DOS; DEC Region 4, Fisheries or Wildlife Manager or Environmental Protection Biologist.

GEOGRAPHIC INFORMATION

**Site Name:** Coxsackie Island Backwater
**Town(s):** Coxsackie, New Baltimore
**County(ies):** Greene
**7.5' Quad(s):** Hudson North, Ravena

REFER TO MAP NUMBER 3

BIOLOGICAL FEATURES

**Community Types:** Predominantly shallows (S) with peripheral mud and sand flats (F), rocky shore (R), lower marsh (L), and upper marsh (U).

**Rare Species:** Heart leaf plantain, kidney leaf mud-plantain.

**Valuable Species:** As a large vegetated backwater, the site is an important spawning and nursery ground for a diverse number of resident fish including brown bullhead, largemouth bass, yellow perch, and redfin pickerel. Also feeding grounds for anadromous fish and wintering areas for largemouth bass.

**Size:** Large shallows area, several small to medium sized marsh, shore, and mud flat areas.

**Quality:** A *low* diversity habitat of *good* quality that has experienced *extensive* disturbance.

**Exotics:** Limited invasion by purple loosestrife (PL) along the fringes of the marsh and by water chestnut (WC) in the northern portion of the backwater.

**General Description:** The shallow littoral area is a vegetated backwater located largely behind Rattlesnake and Coxsackie Islands. Underwater shelter for fish is provided by the many sunken barges in the area. The site's northern shore is mostly sandy beach and unvegetated mudflats while the southern portion exhibits a wetland sequence starting with mudflats and grading into lower and upper marsh areas towards land.

*Figure 38: Northern island shoreline area showing sandy beach and upper marsh.*

## HUMAN INTERACTIONS

**Major Features:** Several marinas (MA), a town park (TP), boat launch (BL), sewage plants (SP), sunken barge hulls, shipping channel (SC), dredging reaches (DR) 26, 27, and 28, dredge disposal (DS) sites 23 and 24S.

**Site History:** The River channel was first dredged between 1926 and 1930 with subsequent maintenance dredging and disposal. Historic shipping activity resulted in the many sunken barges.

**Existing Use:** Extensive fishing and boating activities. A SPDES waste discharge permit was held in the early 1980's by the Coxsackie sewage district. Surface oil films observed in marshes, perhaps originating from marina activities.

**Surrounding Use:** Residential housing (RH), roads, the Village of Coxsackie, natural areas (NA).

**Status & Ownership:** Designated as a Significant Coastal Fish and Wildlife Habitat. The area includes or partially includes State-regulated freshwater wetlands (HN-102). Refer to the official wetland maps available in the Department of Environmental Conservation regional office. The site includes the Natural Heritage Program's Coxsackie Marsh site.

## HABITAT PROTECTION MEASURES

**Site Boundary:** The designated Significant Coastal Fish and Wildlife area should be extended to cover the wetland area north of the town park (dashed line). The buffer zone should include the wooded hillside directly fronting the backwater up to Riverside Avenue along the northern portion of the site, and extending to the 150 foot contour along the southern portion.

**Recommended Actions:** Locate and eliminate source of surface oil in the marsh. Monitor and control any harmful substances associated with outfalls in the south part of the site. Protect the heart leaf plantain from trampling, with fencing, if needed. Clean up trash dumped at the north part of the site near Rattlesnake Island.

**Incompatible Use:** Construction of breakwaters and bulkheads that would alter water flow patterns or eliminate shallows and flats. Dredging the productive shallows and flats. Construction on adjacent lands resulting in erosion and runoff. Winter activities which would affect use by largemouth bass. Expanded marina development or other development that would result in boating traffic largely through shallows and flats.

**Recommended Use:** Increased fishing access.

**Knowledgeable Contacts:** Tom Hart, DOS; DEC Region 4, Fisheries or Wildlife Manager or Environmental Protection Biologist.

## GEOGRAPHIC INFORMATION

**Site Name:** Stockport Creek and Flats

REFER TO MAP NUMBER 3

**Town(s):** Stuyvesant, Stockport, Greenport
**County(ies):** Columbia
**7.5' Quad(s):** Hudson North, Stottville

## BIOLOGICAL FEATURES

**Community Types:** Habitat largely comprised of shallows (S) and mudflats (F). Substantial amounts of lower marsh (L), upper marsh (U), and woody swamp (W). Three miles of tidal and freshwater creek (C). Smaller amounts of deepwater (D) and sandy beach (B) associated with the navigation channel and islands respectively.

**Rare Species:** Heart leaf plantain, estuary beggar-ticks, goldenclub. Substantial map turtle population.

**Valuable Species:** Very important spawning and/or nursery grounds for anadromous and freshwater fish species including alewife, blueback herring, smelt, American shad, striped bass, and smallmouth bass. Very important feeding and resting habitat for migrating and overwintering waterfowl. Use by wading, shore, and passerine birds for feeding and breeding. Bank swallows nest in the vertical sand banks on the southwest shore of Stockport Middle Ground. Extensive stands of wild rice.

**Size:** Vast expanses of shallows and flats. Second largest unobstructed tidal and freshwater stream on the Hudson.

**Quality:** A *high* diversity habitat of *excellent* quality that has experienced *limited* disturbance.

**Exotics:** Limited to moderate invasions of purple loosestrife (PL), common reed (CR), and water chestnut (WC).

**General Description:** Lower and upper marsh areas are located along the eastern shore of Nutten Hook. Rocky shoreline is found facing the River on Nutten Hook. North of Little Nutten Hook are marsh, mudflats, and shallow littoral areas. The tidal cove formed by Gay's Point is mostly shallow littoral areas with patches of lower marsh. Areas from Judson Point south to Stockport Creek include shallow and deep water with beaches around Stockport Middle Ground. Stockport Creek is a large tributary with deep water and shallow areas, and unobstructed tidal and freshwater creek extending three miles upstream, including portions of Claverack and Kinderhook Creeks. South of Stockport Creek is a small upland spit and large marsh and mudflats between the RR track and the River; this area is cut by tidal channels leading to a small arm of Stockport Creek and a culvert under the RR tracks. South of this area is a long stretch of sandy beach and shallow water down to Priming Hook. South of Priming Hook is a large tidal marsh and shallow water area in the cove to the east of the RR tracks. Finally, shallow and deep water areas in the River occur along the entire length of the site.

*Figure 39: Shallows and Stockport Middle Ground from a small tidal creek mouth*

## HUMAN INTERACTIONS

**Major Features:** Residential housing (RH), old abandoned ruins and brick piles (AR), old ferry dock (AR), hunting/squatters shacks (TH), RR bridges and culverts (RB), the railroad track itself, bulkheads (BH), sewage plant (SP), shipping channel (SC), dredging reaches (DR) 28, 29, 31, 32, 33, dredge disposal (DS) sites U-9, 14, 24.

**Site History:** Stockport Middle Ground and extensions to Gay's Point resulted from dredge disposal from original dredging between 1926 and 1930 and subsequent maintenance dredging. Nutten Hook was an industrial site, including ice-houses, brickyards, and a ferry dock. Fifty years ago the forest on Nutten Hook was a field.

**Existing Use:** As part of the Hudson River Islands State Park, the area is a destination point for recreational boaters. The area supports waterfowl hunting during the fall migration, fishing in Stockport Creek and in the River. Used for teaching and research as part of the Hudson River National Estuarine Research Reserve. Nutten Hook is the only site on the River with continuous study of vegetation development on dredge disposal. SPDES waste discharge permits were held in the early 1980's by Lion Brand and Columbia Corporations on tributaries of Stockport Creek. Public lands receive intense and destructive use by campers and boaters. Bank swallow nesting bluffs are threatened by zealous campers clearing vegetation for campsites.

**Surrounding Use:** Residential housing (RH), urban areas, quarries (QU), and natural areas (NA).

**Status:** Designated Significant Coastal Fish and Wildlife Habitat. One of four Federally designated Hudson River National Estuary Research Reserves. Stockport Middle Ground and part of Gay's Point are part of the Hudson River Islands State Park. Includes or partially includes State-regulated freshwater wetlands (HN-1, HN-2, HN-3). Refer to official wetland maps available in the Department of Environmental Conservation regional office. The site includes the Natural Heritage Program's Nutten Hook South Bay, Gay's Point Marsh, and Stockport Creek Marsh sites.

## HABITAT PROTECTION MEASURES

**Site Boundary:** The designated Significant Coastal Fish and Wildlife Habitat area should be extended to the north to include the wetland areas near Nutten Hook (dashed lines). Protection of the site depends on protecting a buffer zone that includes the upland wooded slopes immediately to the east of the site as well as upland areas within the site. The designated significant habitat extends further along the creek than is shown on the map.

**Recommended Actions:** Regulate or control current public uses by providing supervision by on-site personnel and by excluding public use in sensitive areas. Limit use of herbicides along the RR right of way. Increasing tidal circulation in the coves behind the RR may reduce sedimentation and maintain wetland values. Establish active planning and management for recreational use of the islands. Protect rush stands on the flats along the River side of the islands from destruction associated with boat beaching and trampling; evaluate possible solutions. Evaluate River hydrology affecting islands and channels to determine if dominance of flow in the navigation channel has led to increased island erosion and shoaling in the side channels. Evaluate erosion problem at the north end of Stockport Middle Ground and possibly repair the failed bulkhead through placement of surplus dredge material. Alternatively, the Island may be allowed to erode.

**Incompatible Use:** Activities that would subdivide this large habitat or substantially change water flow patterns in the area. Bulkheading and dredging. Subaqueous or littoral dredge disposal except as may be required to provide erosion protection. Discharge of sewage or other pollutants that would concentrate on exposed mudflats. Substantial water withdrawals from Stockport Creek. Marina development within the habitat. Possible long-term degradation from potential waste facility siting in geologically-unstable clay deposit areas.

**Recommended Use:** Low intensity access from old brickyard areas of Nutten Hook, Gay's Point, and Priming Hook. Adequate management controls for existing camping and day uses with boat access should be instituted. Boat access requires walkovers to protect flats from erosion. Additional research and education opportunities.

**Knowledgeable Contacts:** Tom Hart, DOS; Betsy Blair (National Estuarine Research Reserve), Fran Dunwell (DEC Hudson River Coordinator), DEC Region 4, Fisheries, Wildlife Manager or Environmental Protection Biologist. Harold Hagemann (Hudson River Islands State Park)

## GEOGRAPHIC INFORMATION

**Site Name:** Vosburgh Swamp and Middle Ground Flats — REFER TO MAP NUMBER 3
**Town(s):** Coxsackie, Athens
**County(ies):** Greene
**7.5' Quad(s):** Hudson North

## BIOLOGICAL FEATURES

**Community Types:** Largely comprised of creek (C), deepwater (D), shallows (S), and mudflats (F) with lesser amounts of sandy beach (B), lower marsh (L), upper marsh (U), and freshwater swamp (W).

**Rare Species:** Possible least bittern and mud turtle site, heart leaf plantain, subulate arrowhead, estuary beggar-ticks.

**Valuable Species:** Important feeding and resting grounds for migrating waterfowl. Wintering ground for waterfowl when open water is available. One of the few known Hudson River bank swallow colonies is located on Middle Ground Flats. Heavy use of the shallows for American shad spawning and extensive spawning, nursery, and feeding areas for striped bass, alewife, blueback herring, and white perch as well as resident fish species. Extensive nesting for ducks, green-backed herons, and other bird species.

**Size:** Large expanses of all the community types. Extends one-half mile up Murderer's Creek.

**Quality:** A *highly* diverse habitat of *excellent* quality that has experienced *moderate* disturbance.

**Exotics:** Moderate invasion of purple loosestrife (PL), mainly in Vosburgh Swamp.

**General Description:** The north part of the site includes sandy beach and rocky shore along the River. Vosburgh Swamp is a large wetland area cut off from tidal circulation by a low dam across the mouth. West Flats contains an extensive expanse of upper and lower marsh cut by a large channel system and also contains several dredge spoil islands. The River to the west of Middle Ground Flats contains shallow and deep water. Murderer's Creek is accessible to fish up to a dam at Sleepy Hollow Lake. East of Middle Ground Flats is mainly deepwater.

*Figure 40: High marsh and tidal channel in Vosburgh Swamp, looking east.*

## HUMAN INTERACTIONS

**Major Features:** Residential housing (RH), sewage plant (SP), DEC boat launch (BL), marina (MA), tank farm (TF), town park (TP), orchards (AG), bulkhead (BH), small causeway (PI), dam (DA), shipping channel (SC), dredging reaches (DR) 31, 32, 33, and 36, dredge spoil (DS) sites U-9 and several unnumbered small disposal islands.

**Site History:** The River channel was first dredged between 1926 and 1930 with maintenance dredging and spoil deposition occurring subsequently, especially on Middle Ground Flats which were originally constructed out of dredge spoil. Vosburgh swamp has been artificially impounded.

**Existing Use:** Significant waterfowl hunting, fishing, public boat launch area, commercial shad fishing.

**Surrounding Use:** Agricultural areas (AG), residential housing (RH), the Village of Athens, natural areas (NA).

**Status:** Designated as a Significant Coastal Fish and Wildlife Habitat. The area wholly or partially includes State-regulated freshwater wetlands (HN-109, HN-113, HN-114). Refer to the official wetland maps available at the Department of Environmental Conservation regional office. The site includes the Natural Heritage Program's West Flats site.

## HABITAT PROTECTION MEASURES

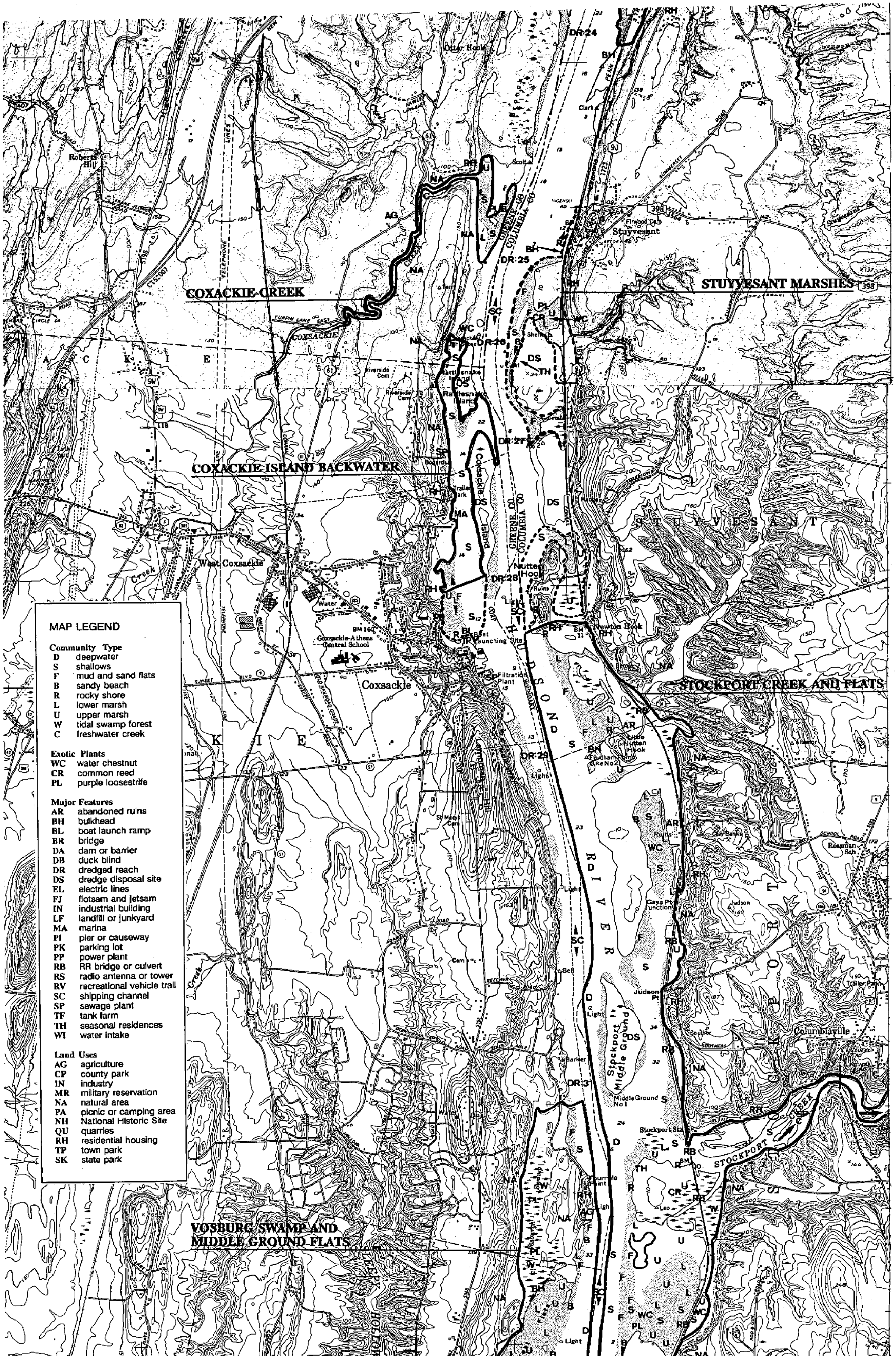
**Site Boundary:** Includes the entire designated Significant Coastal Fish and Wildlife Habitat area. Buffer zone should include the upland wooded community to the west of the site extending to the crest of the bluffs (The 150 foot contour north of Murderer's Creek and approximately the 50 foot contour south of the creek).

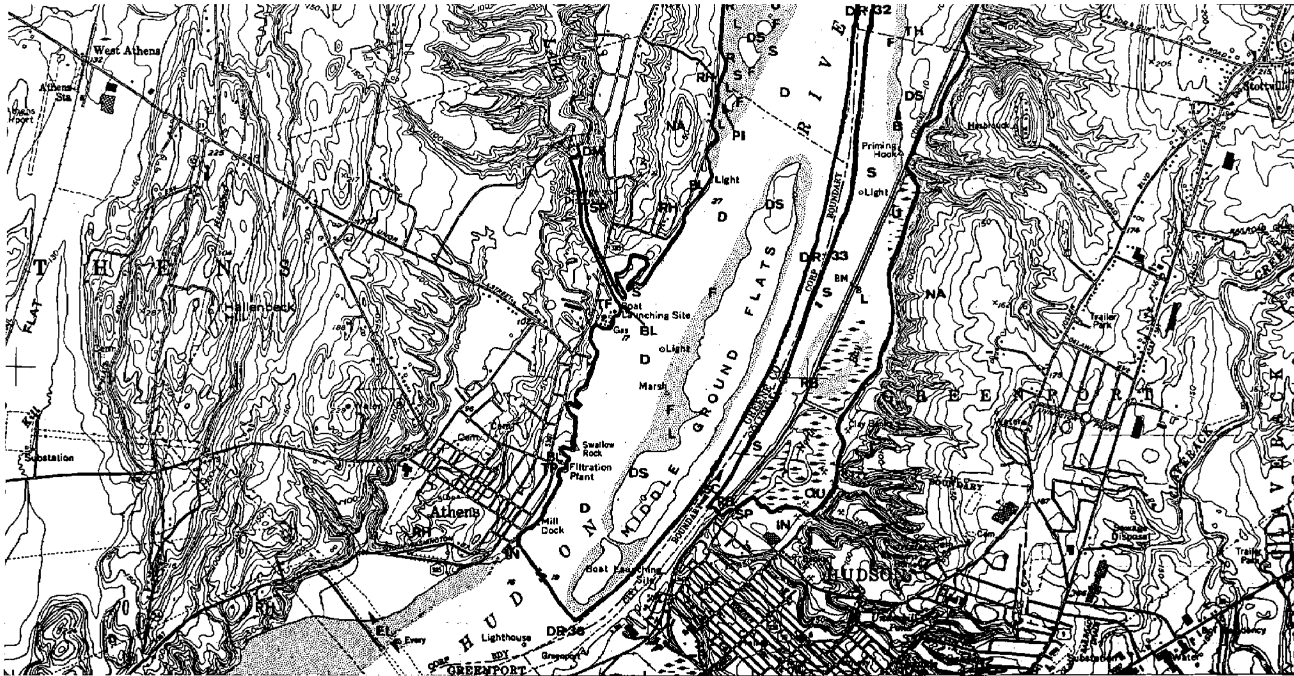
**Recommended Actions:** Research the effects on maintaining wetland values that may result from additional tidal flow into Vosburgh Swamp. Research effects of the release of water from the dam at Sleepy Hollow Lake on the fish use of the creek and optimize flows for fish spawning. Identify and control sources of sediment such as deteriorated bulkheads and storm drains. Determine where dredging is needed in specific instances where siltation from upland sources is degrading habitat values; take preventive measures to control sediment sources and reduce the need for localized dredging.

**Incompatible Use:** Any activity that would interfere with the habitat functions of the site. Dredging, new bulkheading, and development in the habitats. Marina development that would result in boating traffic within shallows and flats. Clearing vegetation to the extent that erosion of adjacent land would occur.

**Recommended Use:** Enhanced fishing opportunities.

**Knowledgeable Contacts:** Tom Hart, DOS; DEC Region 4, Fisheries or Wildlife Manager or Environmental Protection Biologist.


COXACKIE CREEK
STUYVESANT MARSHES
COXACKIE ISLAND BACKWATER
STOCKPORT CREEK AND FLATS
VOSBURG SWAMP AND
MIDDLE GROUND FLATS
Stuyvesant
West Coxsackie
Coxsackie
Coxsackie-Athens Central School
Newton Hook
Nutten Hook
Columbiaville
Stockport Middle Ground
Rattlesnake Island
Coxsackie Island
HUDSON RIVER
STUYVESANT
STOCKPORT
GREENE CO
COLUMBIA CO
MAP LEGEND
Community Type
D deepwater
S shallows
F mud and sand flats
B sandy beach
R rocky shore
L lower marsh
U upper marsh
W tidal swamp forest
C freshwater creek
Exotic Plants
WC water chestnut
CR common reed
PL purple loosestrife
Major Features
AR abandoned ruins
BH bulkhead
BL boat launch ramp
BR bridge
DA dam or barrier
DB duck blind
DR dredged reach
DS dredge disposal site
EL electric lines
FJ flotsam and jetsam
IN industrial building
LF landfill or junkyard
MA marina
PI pier or causeway
PK parking lot
PP power plant
RB RR bridge or culvert
RS radio antenna or tower
RV recreational vehicle trail
SC shipping channel
SP sewage plant
TF tank farm
TH seasonal residences
WI water intake
Land Uses
AG agriculture
CP county park
IN industry
MR military reservation
NA natural area
PA picnic or camping area
NH National Historic Site
QU quarries
RH residential housing
TP town park
SK state park




**HUDSON RIVER TIDAL HABITATS** **MAP NUMBER 3**

**Coxsackie Creek / Coxsackie Island Backwater / Stuyvesant Marshes / Stockport Creek and Flats / Vosburgh Swamp and Middle Ground Flats**

Miles

0 ½ 1

N

New York State Department of State Division of Coastal Resources and Waterfront Revitalization

Prepared by T. Hart and N. Salafsky December 1989

GEOGRAPHIC INFORMATION

**Site Name:** Roger's Island
**Town(s):** Greenport
**County(ies):** Columbia
**7.5' Quad(s):** Hudson South

REFER TO MAP NUMBER 4

BIOLOGICAL FEATURES

**Community Types:** Comprised of roughly equal amounts of shallows (S) and mudflats (F) with lesser amounts of sandy beach (B), lower marsh (L), upper marsh (U), and swamp forest (W).

**Rare Species:** Estuary beggar-ticks, two stands of larger-sized goldenclub.

**Valuable Species:** Extensive waterfowl use during migrations and overwintering, nesting sites for many birds, extensive spawning areas for anadromous fish including especially American shad.

**Sizes:** Extensive shallows and mudflats concentrated at the south and north ends of Roger's Island, large lower marshes and rice-dominated upper marshes, one of the largest tidal swamp forests on the Hudson and in NYS.

**Quality:** A *highly* diverse habitat of *excellent* quality that has experienced *limited* disturbance.

**Exotics:** Limited invasion by purple loosestrife and common reed along marsh edges.

**General Description:** Productive wetland areas of the island occur in and along Hallenbeck Creek, in and along the creek at the south end of the island, in the swamp forest in the southeast part of the island, in the two marsh areas along the west shore, and in the extensive flats at the north and south ends of the islands. The western portion of the island is not tidally influenced and is covered with secondary coniferous forest and scrubby undergrowth.

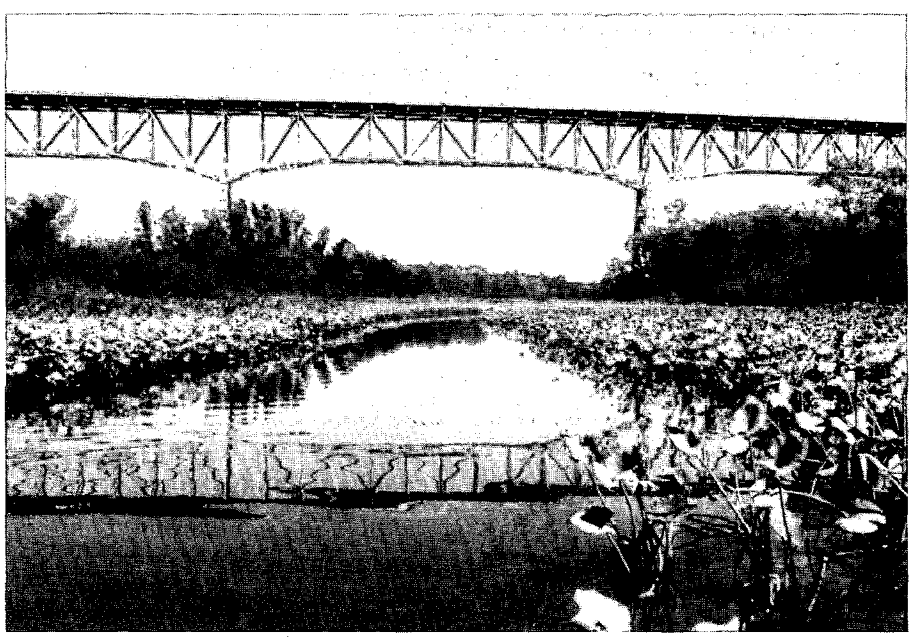


*Figure 41: Roger's Island backwater, looking north*

## HUMAN INTERACTIONS

**Major Features:** Limited bulkheads along west side (BH), Rip Van Winkle Bridge (BR), informal picnic/camping areas (PA), RR track forms the eastern border, extensive flood flotsam (FJ), shipping channel (SC), dredging reach (DR) 39.

**Site History:** The Island was formed naturally, although dredged material has been placed on the northern end. The River channel was first dredged in the 1930's with maintenance dredging occurring subsequently. The Rip Van Winkle Bridge was built in 1934.

**Existing Use:** Extensive waterfowl hunting, informal camping, extensive commercial shad fishing.

**Surrounding Use:** The island itself is separated from the upland by the RR right of way and Hallenbeck Creek. One small farm field (AG) nearby, orchards, limited residential housing (RH), and extensive natural areas (NA) in the uplands to the east.

**Status:** Designated as a Significant Coastal Fish and Wildlife Habitat. Roger's Island proper is owned by the State and administered by the Department of Environmental Conservation as a Wildlife Management Area. The area wholly or partially includes State-regulated freshwater wetlands (HS-1). Refer to the official wetland maps available in the Department of Environmental Conservation regional office. The site includes the Natural Heritage Program's Roger's Island site.

## HABITAT PROTECTION MEASURES

**Site Boundary:** Includes the entire designated Significant Coastal Fish and Wildlife Habitat area. The buffer zone should include the upland areas to the east, as far as Mt. Marino Road to the north and Route 9J to the south.

**Recommended Actions:** Clean up flood flotsam, ensure that herbicides from the RR are not entering the creek. Establish bridge maintenance practices to control entry of runoff from the bridge and associated interchanges and to limit entry of maintenance debris such as paint and sand-blasting materials.

**Incompatible Use:** Marinas or other development that would disturb the area or result in boating traffic within the shallows and flats. Any permanent building or structure (such as a bridge to the island) that would increase uncontrolled public access. Dredge disposal on or near the tidally-influenced portions of the Island. Direct loss of habitat associated with bridge maintenance or expansion.

**Recommended Use:** Managed waterfowl area, picnic area, controlled access from the River.

**Knowledgeable Contacts:** Tom Hart, DOS; DEC Region 4, Fisheries or Wildlife Manager or Environmental Protection Biologist.

GEOGRAPHIC INFORMATION

REFER TO MAP NUMBER 4

**Site Name:** Catskill Creek
**Town(s):** Catskill
**County(ies):** Greene
**7.5' Quad(s):** Hudson South, Cementon

BIOLOGICAL FEATURES

**Community Types:** Predominantly creek with small amounts of shallows (S), mudflats (F), and lower marsh (L).

**Rare Species:** Wood turtle reported in the area, probably in association with adjacent buffer area.

**Valuable Species:** Important spawning and nursery grounds for anadromous and resident fishes including American shad, alewife, blueback herring, white perch, and smallmouth and largemouth bass.

**Sizes:** Five miles of the creek of which the lower 1.5 miles are tidally influenced. Narrow strips of mudflats and lower marsh along the creek banks. The Catskill creek watershed covers over 270 square miles.

**Quality:** A *low* diversity habitat of *good* quality that has experienced *extensive* disturbance.

**Exotics:** None noted.

**General Description:** The tidal portions of this site contain both shallows and deepwater areas as well as thin strips of mudflats along the sides of the channel. The upper portions of the site accessible to fish include several miles of Catskill Creek and part of Kaaterskill Creek which are both fast moving cold water streams.

*Figure 42: Catskill Creek, looking west*

## HUMAN INTERACTIONS

**Major Features:** A large marina (MA), tank farm (TF), bulkheading along the north side (BH), highway and railroad crossings, extensive village development, dredging of the creek bottom (DR), sewage plant (SP), town park (TP).

**Site History:** The creek was dredged in the early part of the twentieth century.

**Existing Use:** Extensive recreational fishing and boating, large marina, commercial shad fishing. A SPDES waste discharge permit was held in the early 1980's by the Catskill Sewage District.

**Surrounding Use:** The lower portions of the creek are surrounded by the Village of Catskill. Upper portions are adjacent to quarries (QU) and scattered residential housing (RH) and natural areas (NA).

**Status:** Designated as a Significant Coastal Fish and Wildlife Habitat.

## HABITAT PROTECTION MEASURES

**Site Boundary:** Includes the entire designated Significant Coastal Fish and Wildlife Habitat area. The buffer zone should contain the upland watershed on both sides of Catskill and Kaaterskill Creeks to the crest of the associated bluffs.

**Recommended Actions:** Monitor and prevent spillage into the habitat from the fuel tanks north of the Creek. Enforce existing regulations prohibiting discharges from boats at the marina. Avoid contamination of the Creek from wastes resulting from bridge maintenance activities. Avoid dredging in the Creek during fish spawning periods. Institute stormwater and non-point pollution control programs in the Village.

**Incompatible Use:** Direct or indirect discharge of chemicals and other pollutants, extensive development of the creek bank and watershed resulting in increased runoff, construction of dams and other barriers to fish. Extensive expansion of marinas which would degrade spawning habitat.

**Recommended Use:** Increased access for recreational fishing within the creek.

**Knowledgeable Contacts:** Tom Hart, DOS; DEC Region 4, Fisheries or Wildlife Manager or Environmental Protection Biologist.

## GEOGRAPHIC INFORMATION

**Site Name:** Ramshorn Marsh
**Town(s):** Catskill
**County(ies):** Greene
**7.5' Quad(s):** Hudson South, Cementon

REFER TO MAP NUMBER 4

## BIOLOGICAL FEATURES

**Community Types:** Largely shallows (S), mudflats (F), lower marsh (L), upper marsh (U), and swamp forest (W) with lesser amounts of sandy beach (B) and rocky shore (R).

**Rare Species:** Least bittern nesting, estuary beggar-ticks, heart leaf plantain.

**Valuable Species:** Waterfowl use during migrations and overwintering, important heron feeding grounds, furbearer habitat, spawning and nursery grounds for American shad and black bass.

**Sizes:** Large shallows and mudflats along River, a long strip of sandy beach, large tract of upper marsh, one of the largest tidal swamp forests along the Hudson.

**Quality:** A *highly* diverse habitat of *excellent* quality that has experienced *limited* disturbance.

**Exotics:** Very limited patches of purple loosestrife and common reed (CR).

**General Description:** Starting from the River, there is a wide shallows area covered with aquatic plants. Moving inland, there is a narrow portion of lower marsh followed by a narrow sand and mud flat. The upper marsh is elevated 1-2 feet above the lower marsh and extends to the west for 200-300 feet. This upper marsh is cut by several small drainage channels and Ramshorn Creek. West of the upper marsh is an extensive swamp area that has alternate sections of shrubby and forested areas as well as several small streams including Mineral Spring Brook. There is also a medium sized area of shallows, mudflat, and lower marsh along the small creek joining Catskill Creek in the north of the site and an extensive rocky shore area along the south portion of the site.

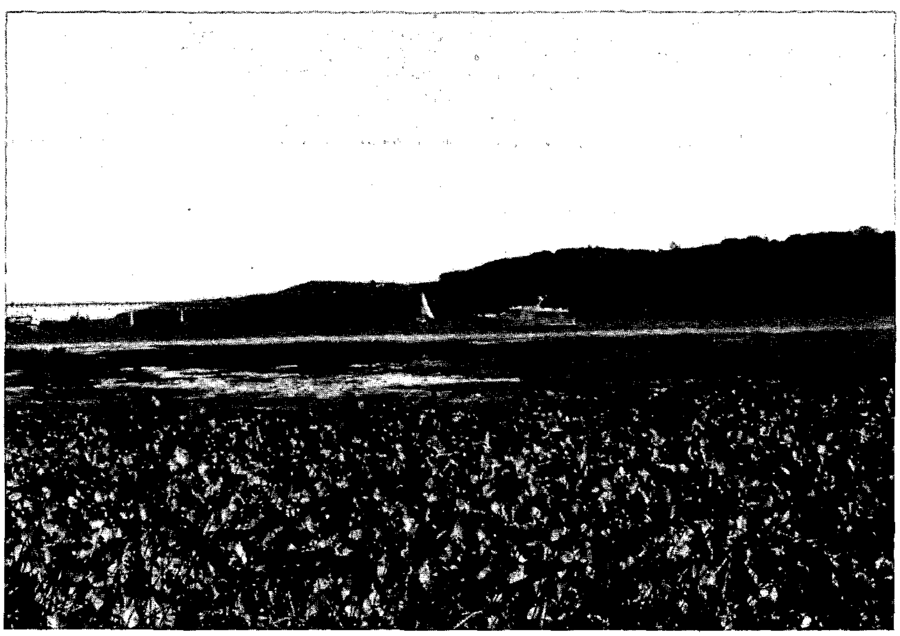


*Figure 43: Shore-parallel bands of low marsh, flats, and shallows at Ramshorn Marsh, looking northeast*

## HUMAN INTERACTIONS

**Major Features:** Duck blinds (DB), residential housing (RH), marina (MA), tank farm (TF), sewage plant (SP), town park (TP), shipping channel (SC), dredging reach (DR) 47.

**Site History:** The River channel was first dredged in the 1930's with maintenance dredging and spoil deposition occurring subsequently. Several causeways and road extensions traverse the swamp.

**Existing Use:** Extensive waterfowl hunting, bird watching, nature sanctuary, bass and shad fishing. A SPDES waste discharge permit was held in the early 1980's by the Catskill sewage district.

**Surrounding Use:** Residential housing (RH), the Village of Catskill, natural areas (NA).

**Status:** Designated as a Significant Coastal Fish and Wildlife Habitat.

## HABITAT PROTECTION MEASURES

**Site Boundary:** Includes the entire designated Significant Coastal Fish and Wildlife Habitat area. The buffer zone should include the upland forests to the west of the site and the Burger, Ramshorn and Dubois Creek watersheds.

**Recommended Actions:** Monitor fuel tanks to the north for spills entering the significant habitat. Monitor erosion of the upper marsh edge along the River, particularly for effects of sediment entering the marsh. Survey common reed at the north part of the site that may be spreading in association with eroding soils. Stop mowing heart leaf plantain plants along the southern shore through education and fencing if needed. Much of the upland to the west is agricultural land under threat of residential development; preserve these areas in their current use through appropriate easements.

**Incompatible Use:** Any activity that would subdivide the overall site into smaller units, such as additional road construction. Any construction activities in the shallows and marshes. Activities that would disturb the swamp forest areas and their existing hydrology. Bulkheading of any of the streams in the area or the River shore itself.

**Recommended Use:** An ideal education and research site since it contains virtually all the different community types found along the River.

**Knowledgeable Contacts:** Tom Hart, DOS; Betsy Blair, National Estuarine Research Reserve. DEC Region 4, Fisheries or Wildlife Manager or Environmental Protection Biologist.

## GEOGRAPHIC INFORMATION

**Site Name:** Inbocht Bay and Duck Cove
**Town(s):** Catskill
**County(ies):** Greene
**7.5' Quad(s):** Cementon

REFER TO MAP NUMBER 4

## BIOLOGICAL FEATURES

**Community Types:** Principally shallows (S) and mudflats (F), with some lower marsh (L).

**Rare Species:** Estuary beggar-ticks.

**Valuable Species:** Very extensive waterfowl concentrations during spring and fall migrations, some waterfowl overwintering, large muskrat and snapping turtle populations.

**Sizes:** A huge expanse of shallow littoral zones and mudflats with a narrow fringe of lower marsh along the shoreline.

**Quality:** A *moderately* diverse habitat of *good* quality that has experienced *moderate* disturbance.

**Exotics:** Limited invasion of purple loosestrife (PL) along the shore.

**General Description:** Inbocht Bay and Duck Cove form a very large, shallow backwater area of the River. There is extensive coverage of the area with aquatic plants and, a narrow, long band of lower marsh along the shore.

*Figure 44: View across Inbocht Bay to the south*

## HUMAN INTERACTIONS

**Major Features:** Hunting cabins (TH), cement plants and loading facilities (IN), pasture areas (AG), cement loading piers (PI), an old stone dike extending north from Silver Point to the dredge spoil island, shipping channels (SC), dredging reaches (DR) 47 and 48, dredge spoil (DS) sites U-16 and 17.

**Site History:** The River channel was first dredged in the 1930's with extensive maintenance dredging and spoil deposition occurring subsequently. The islands in the bay were artificially created from dredge spoil. Industrial development has modified the shoreline and shallows, including construction of piers and use of deep draft vessels.

**Existing Use:** Extensive waterfowl hunting, cement manufacture and transport. A SPDES waste discharge permit was held in the early 1980's by Lehigh Portland Cement Co.

**Surrounding Use:** Agricultural pasture (AG), cement factories (IN), cement quarries (QU), natural areas (NA).

**Status:** Designated as a Significant Coastal Fish and Wildlife Habitat. The area wholly or partially includes State-regulated freshwater wetlands (HS-101). Refer to the official wetland maps available in the Department of Environmental Conservation regional office. The site includes the Natural Heritage Program's Inbocht Bay site.

## HABITAT PROTECTION MEASURES

**Site Boundary:** Includes the entire Significant Coastal Fish and Wildlife Habitat area. Buffer zone should include the watershed of Mineral Springs Creek and the immediately adjacent upland slopes and industrial areas.

**Recommended Actions:** Monitor and control any pollutants entering the site from the cement plants, loading facilities and agricultural areas.

**Incompatible Use:** Dredging that would disrupt the productive shallows including aqueous dredge spoil disposal. Development of marinas. Additional large-scale development of the bay and the surrounding watershed that would result in increased runoff or sedimentation. Discharge of agricultural and industrial pollutants.

**Recommended Use:** Managed waterfowl area.

**Knowledgeable Contacts:** Tom Hart, DOS; DEC Region 4, Fisheries or Wildlife Manager or Environmental Protection Biologist.

GEOGRAPHIC INFORMATION

**Site Name:** Roeliff-Jansen Kill
**Town(s):** Germantown, Livingston, Clermont
**County(ies):** Columbia
**7.5' Quad(s):** Hudson South, Clermont

REFER TO MAP NUMBER 4

BIOLOGICAL FEATURES

**Community Types:** Predominantly freshwater creek (C) with limited shallows (S), mudflats (F), and lower marsh (L).

**Rare Species:** None currently identified.

**Valuable Species:** Extensive use as a spawning and/or nursery ground for anadromous fishes including American shad, blueback herring, white perch and striped bass. American shad spawning near the Kill mouth. The Kill provides spawning and nursery grounds for River-resident smallmouth bass that move upstream in spring. Upper reaches include resident brown trout.

**Sizes:** Six miles along the stream of which the first half mile is tidal. Small marsh and mudflats areas at the stream mouth.

**Quality:** A *low* diversity habitat of *fair* quality that has experienced *moderate* disturbance.

**Exotics:** Moderate invasion of purple loosestrife along the fringes of the lower marsh.

**General Description:** Roeliff-Jansen Kill is a large, medium gradient, cool-water stream draining a large, predominantly agricultural watershed. The tidal wetland areas are concentrated in two locations near the mouth of the creek. West of the RR bridge is a small area of shallow water and mudflats behind a small, sandy, dredge spoil island. East of the bridge the stream mouth divides into several channels between which are islands covered with scrub and weedy marsh plants. The banks of the creek are very steep, precluding marsh formation except in small pockets.

*Figure 45: Roeliff-Jansen Kill looking east from footbridge.*

## HUMAN INTERACTIONS

**Major Features:** Highway and railroad bridges over the stream (RB), RR track forms border to shallow zones in the River, dredge spoil island (DS), boat launch ramp (BL), residential housing (RH), shipping channel (SC).

**Site History:** The River channel was first dredged in the 1930's with subsequent maintenance dredging and spoil disposal.

**Existing Use:** Significant recreational fishing, small recreational boat launching. Significant commercial American shad fishing and boat access.

**Surrounding Use:** Residential housing (RH), natural areas (NA), agriculture (AG) along the upstream portions of the creek.

**Status:** Designated as a Significant Coastal Fish and Wildlife Habitat. The area wholly or partially includes State-regulated freshwater wetlands (HS-11). Refer to the official wetland maps available at the Department of Environmental Conservation regional office.

## HABITAT PROTECTION MEASURES

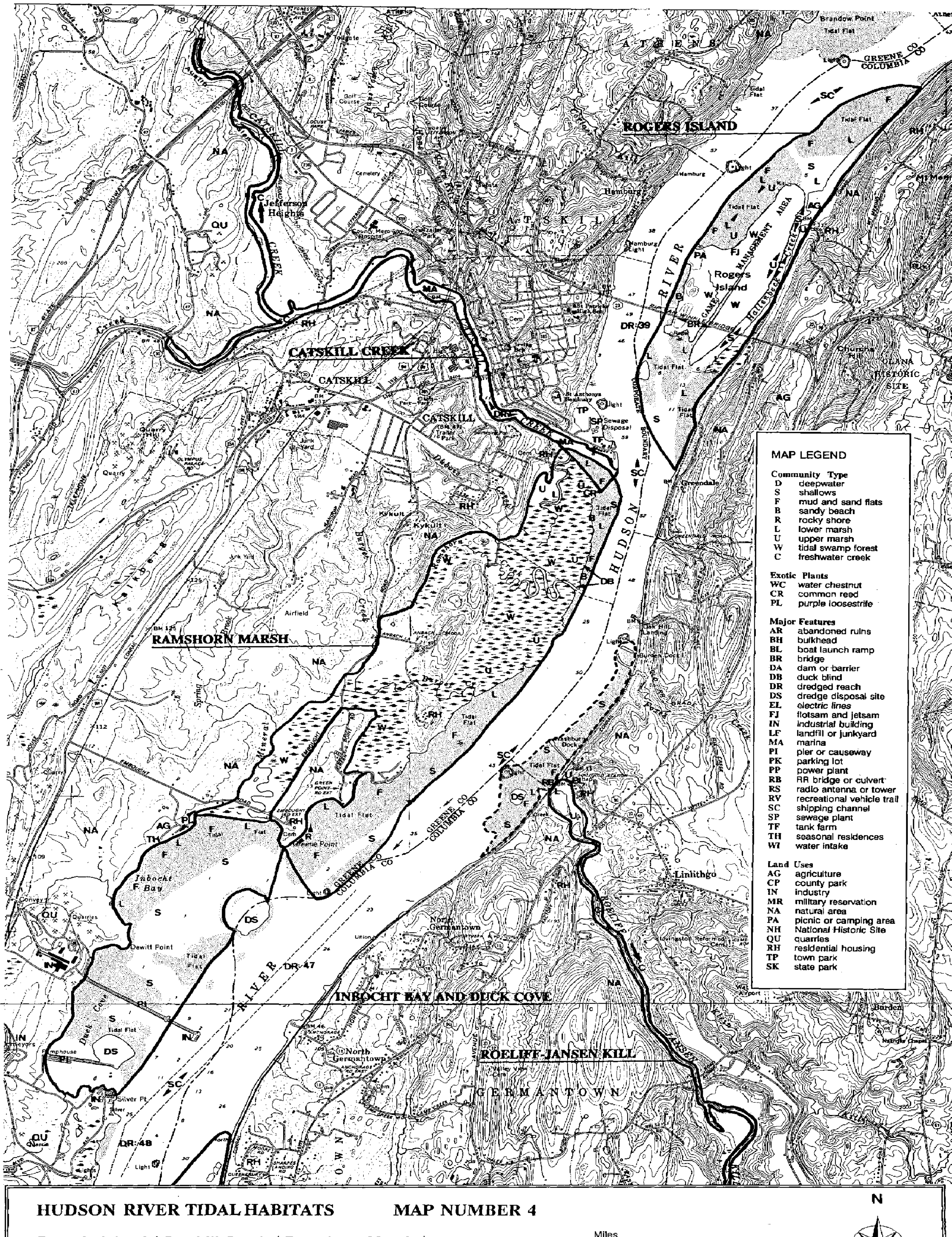
**Site Boundary:** The Significant Coastal Fish and Wildlife Habitat boundary should be extended to include the portions of the site located west of the railroad tracks that were not included in the original designation (dashed line). The buffer zone should include the watershed along the creek to the crest of the steep bluffs or to other sources of runoff. The designated significant habitat boundary extends further up the creek than is shown on the map.

**Recommended Actions:** Monitor and limit upstream agricultural runoff. Protect the adjacent bluffs from deforestation and any other activities resulting in erosion. Establish protection through a watershed management program focusing on agricultural soil conservation practices. Evaluate the effects of the Washburn Dock on sedimentation at the mouth of the Kill. Limit the need for dredging at the Kill mouth increasing water flow through the deteriorating dock. Limit channel dredging scope and restrict dredging to late summer or fall.

**Incompatible Use:** Dredging the creek or the wetlands and shallows near its mouth for expanded boat access. Physical or chemical barriers to fish movements. Clearing vegetation or other activities that would introduce sediment, increase turbidity or increase water temperatures within the Kill.

**Recommended Use:** Increased fishing access.

**Knowledgeable Contacts:** Tom Hart, DOS; DEC Region 4, Fisheries or Wildlife Manager or Environmental Protection Biologist.




**HUDSON RIVER TIDAL HABITATS** **MAP NUMBER 4**

**Roger's Island / Catskill Creek / Ramshorn Marsh / Roeliff-Jansen Kill / Inbocht Bay and Duck Cove**

Miles

0 ½ 1

N

New York State Department of State Division of Coastal Resources and Waterfront Revitalization

Prepared by T. Hart and N. Salafsky December 1989

## GEOGRAPHIC INFORMATION

**Site Name:** Smith's Landing Cementon

REFER TO MAP NUMBER 5

**Town(s):** Catskill, Saugerties
**County(ies):** Greene, Ulster
**7.5' Quad(s):** Cementon

## BIOLOGICAL FEATURES

**Community Types:** Limited mudflats (F), lower marsh (L), and upper marsh (U).

**Rare Species:** Heart leaf plantain, kidney leaf mud-plantain.

**Valuable Species:** None identified.

**Sizes:** Small mudflats and marsh areas.

**Quality:** A *low* diversity habitat of *good* quality that has experienced *limited* disturbance.

**Exotics:** Limited invasion by purple loosestrife (PL).

**General Description:** A small tidal cove that exhibits a progression starting with mudflats and moving through lower and upper marsh areas.

*Figure 46: Tidal cove showing lower and upper marsh at Smith's Landing.*

## HUMAN INTERACTIONS

**Major Features:** Residential housing (RH), bulkheads (BH), boat docks (MA), town park (TP), shipping channel (SC).

**Site History:** None identified.

**Existing Use:** Boat launches.

**Surrounding Use:** Residential housing (RH), the Village of Cementon.

**Status:** Recognized by the NY Natural Heritage Program as containing moderately significant intertidal mudflats. The area wholly or partially includes State-regulated freshwater wetlands (C-25). Refer to the official wetland maps available at the Department of Environmental Conservation regional office.

## HABITAT PROTECTION MEASURES

**Site Boundary:** The site boundary shown is from the NY Natural Heritage Program. The buffer zone should include the immediate upland to the west, including the small tributary creek.

**Recommended Actions:** Monitor and control runoff entering the habitat and contributing sediments or pollutants from the surrounding roads. Establish watershed management practices such as maintenance of natural vegetation buffers.

**Incompatible Use:** Dredging or development that would alter or destroy the habitat. Any activity that would reduce flow of the tributary stream or increase its sediment load.

**Recommended Use:** None identified, based on the need to protect rare plants.

**Knowledgeable Contacts:** Tom Hart, DOS; DEC Region 4, Fisheries or Wildlife Manager or Environmental Protection Biologist. Carol Reschke and Caryl Devries, The Nature Conservancy.

GEOGRAPHIC INFORMATION

**Site Name:** Germantown/Clermont Flats

REFER TO MAP NUMBER 5

**Town(s):** Germantown, Clermont
**County(ies):** Columbia
**7.5' Quad(s):** Cementon, Saugerties

BIOLOGICAL FEATURES

**Community Types:** Deepwater (D), shallows (S), mudflats (F) and limited lower marsh (L).

**Rare Species:** None identified.

**Valuable Species:** Extremely important American shad spawning area, nursery areas for shad, striped bass, white perch, resident fishes. Extensive waterfowl feeding grounds during spring and fall migration periods. Some waterfowl overwintering use.

**Sizes:** Very large expanses of shallow littoral areas and mudflats.

**Quality:** A *low* diversity habitat of *good* quality that has experienced *limited* disturbance.

**Exotics:** None known.

**General Description:** One of the largest continuous areas of shallows and mudflats on the Hudson with abundant aquatic plant growth including water celery and eelgrass.

HUMAN INTERACTIONS

**Major Features:** Adjacent to the shipping channel (SC) and dredging reach (DR) 48. Extensive commercial shad fishing.

**Site History:** The River channel was first dredged in the 1930's with subsequent maintenance dredging and disposal.

**Existing Use:** Extensive commercial shad fishing, recreational fishing. A SPDES waste discharge permit was held in the early 1980's by the Lehigh Portland Cement Company.

**Surrounding Use:** Residential housing (RH), natural areas (NA), agricultural lands (AG), villages, Clermont State Park (SK).

**Status:** Designated as a Significant Coastal Fish and Wildlife Habitat.

HABITAT PROTECTION MEASURES

**Site Boundary:** Includes the entire designated Significant Coastal Fish and Wildlife Habitat area. The buffer zone should include the upland along the eastern shore of the River as far as Woods Road. Watersheds of small streams discharging in the area may also affect the area. Adjacent sections within the River itself should be included in a buffer since the area's value depends on overall water quality.

**Recommended Actions:** Undertake dredging of the channel only in late summer or mid to late winter to avoid disrupting the fish and bird uses of the area. Restrict recreational boat use over the shallows and direct boat traffic over deeper waters, especially during fish spawning and waterfowl feeding times. Continue efforts to improve the overall water quality of the River. Protect the area as a research reserve and as a sanctuary with limited non-resource related recreational use.

**Incompatible Use:** Any new navigation channels cut through the area, dredge spoil disposal, marinas along the shore bordering the site and other development that would result in boating traffic through the area.

**Recommended Use:** Increased small boat fishing, research on shallow water spawning fishes.

**Knowledgeable Contacts:** Tom Hart, DOS; DEC Region 4, Fisheries or Wildlife Manager or Environmental Protection Biologist.

## GEOGRAPHIC INFORMATION

**Site Name:** Esopus Estuary

REFER TO MAP NUMBER 5

**Town(s):** Saugerties, Red Hook
**County(ies):** Ulster, Dutchess
**7.5' Quad(s):** Saugerties

## BIOLOGICAL FEATURES

**Community Types:** Comprised of freshwater creek (C), deepwater (D), shallows (S), mudflats (F), lower marsh (L), upper marsh (U), and a small amount of tidal swamp forest (W).

**Rare Species:** Shortnose sturgeon spawning and wintering area in the deepwater portion of the River, migrating osprey feeding grounds, heart leaf plantain, goldenclub.

**Valuable Species:** Important spawning and nursery grounds for striped bass, white perch, American shad, alewife, blueback herring, rainbow smelt, and resident fish. Feeding and resting grounds for migrating waterfowl.

**Sizes:** Large areas of mudflat, marsh, shallows, and deepwater habitat. Small area of tidal swamp. Esopus creek is accessible to River fish for 1.3 miles up to a large waterfall.

**Quality:** A *moderately* diverse habitat of *good* quality that has experienced *moderate* disturbance.

**Exotics:** Limited invasions of exotics overall with moderate to severe invasions of purple loosestrife (PL) and water chestnut (WC) in small areas.

**General Description:** The site includes two coves with a marsh/mudflat/shallows series north of the creek mouth, a large mudflats just south of the creek mouth, a large upper marsh area along the south side of the creek channel, a cove with mudflats and lower marsh just north of the long causeway, a small section of shrubby tidal swamp on either side of the causeway, a large cove with mudflats and lower marsh south of the causeway, a deepwater section of the River in the east, and a small tidal portion of Esopus Creek.

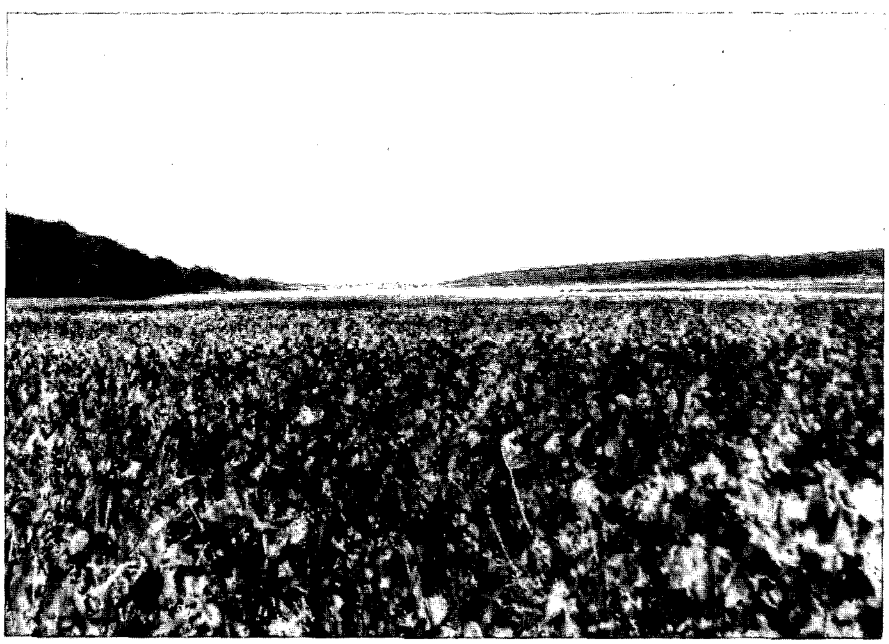


*Figure 47: Marsh area north of the Esopus Creek mouth.*

## HUMAN INTERACTIONS

**Major Features:** Extensive bulkheading (BH), residential housing (RH), a long causeway (PI), dredged channel areas (DR), marina (MA), duck blinds (DB), sewage plant (SP), Coast Guard station, shipping channel (SC).

**Site History:** The natural sedimentation patterns of the site have been radically altered by the construction of the causeway and bulkheads extending the creek channel. The creek channel was first dredged in 1929 with subsequent maintenance dredging in 1935 and 1968.

**Existing Use:** Black and striped bass fishing including several tournaments, limited duck hunting. A SPDES waste discharge permit was held in the early 1980's by Ferroxcube Co.

**Surrounding Use:** Residential housing (RH), the Village of Saugerties, natural areas (NA), small villages.

**Status:** Designated as a Significant Coastal Fish and Wildlife Habitat. The area wholly or partially includes State-regulated freshwater wetlands (S-2, S-3). Refer to the official wetland maps available in the Department of Environmental Conservation regional office. The site includes the Natural Heritage Program's Saugerties Marsh and Esopus Estuary sites.

## HABITAT PROTECTION MEASURES

**Site Boundary:** Includes the entire designated Significant Coastal Fish and Wildlife Habitat area. The buffer zone should include the undeveloped upland woods within the Creek's watershed and the immediate banks and slopes within the Village.

**Recommended Actions:** Minimize human activities in the area during osprey migration times in mid-April and early May. Examine the potential of increasing tidal flow or otherwise reducing sedimentation in the large upper marsh area to possibly reduce spread of purple loosestrife. Implement stormwater runoff and other non-point pollution control programs in the Village.

**Incompatible Use:** Activities that would decrease stream flow from Esopus Creek. Dredging or filling. Intensive marina development in the Creek. Marina development that would result in boating traffic within the shallows and flats.

**Recommended Use:** Fishing from the jetty, access through construction of boardwalks associated with the lighthouse.

**Knowledgeable Contacts:** Tom Hart, DOS; DEC Region 3, Fisheries or Wildlife Manager or Environmental Protection Biologist.

GEOGRAPHIC INFORMATION

**Site Name:** North and South Tivoli Bays

REFER TO MAP NUMBER 5

**Town(s):** Red Hook
**County(ies):** Dutchess
**7.5' Quad(s):** Saugerties

BIOLOGICAL FEATURES

**Community Types:** Comprised of shallows (S), lower marsh (L) and upper marsh (U), followed by tidal swamp forest (W), rocky shore (R) and creeks (C).

**Rare Species:** Migrating osprey feeding and resting, map turtle use, least bittern nesting, king rail, heart leaf plantain, estuary beggar-ticks, goldenclub, other rare plants.

**Valuable Species:** Feeding, spawning, and/or nursery areas for striped bass, alewife, blueback herring, largemouth and smallmouth bass, and other fishes. A large snapping turtle population. Extensive waterfowl use for feeding and resting during migrations. Many other breeding bird populations. Furbearer habitat.

**Size:** Large expanses of all community types except tidal swamp forest which is found in a medium sized patch on the lowland separating North and South bays and in a small patch at Stony Creek.

**Quality:** A *highly* diverse habitat of *good* quality that has experienced *moderate* disturbance.

**Exotics:** North Bay has limited invasion of water chestnut (WC) and purple loosestrife (PL), South Bay has severe invasion of water chestnut (WC).

**General Description:** South Bay is largely comprised of tidal shallows and mudflats that are covered with water chestnut plants from mid-June through early October. North Bay has a complex network of shallow water channels that are lined with lower marsh, deeply penetrating areas of upper marsh. West of the RR track is a large area of shallow water covered with aquatic vegetation and including two islands that have marsh and/or shore associated with them. Two freshwater streams enter the bays: Saw Kill into South Bay and Stony Creek into North Bay.

*Figure 48: Tivoli North Bay. Photo by Bryan Swift/DEC*

## HUMAN INTERACTIONS

**Major Features:** The railroad forms the west boundary of the bays which are connected to the River by five bridges (RB). Other features include college buildings (RH), sewage plant (SP), water intake (WI), and shipping channel (SC).

**Site History:** Hydrological and sedimentation patterns in the site were greatly altered when the railroad was built in the 1850's. A swamp region near Cruger Island was diked in the 1800's to form an ornamental garden that has since reverted to swamp.

**Existing Use:** Waterfowl hunting, bass fishing, limited muskrat and snapping turtle trapping, extensive bird watching, scientific research, and nature study. Active interpretive programs.

**Surrounding Use:** Bard College, villages, residential housing (RH), agriculture (AG), natural areas (NA).

**Status:** Designated as a Significant Coastal Fish and Wildlife Habitat. One of four designated Hudson River National Estuarine Research Reserve sites. Upland areas state-owned and administered by the NYS Department of Environmental Conservation as a State Wildlife Management Area. The area wholly or partially includes State-regulated freshwater wetlands (SG-3). Refer to the official wetland maps available at the Department of Environmental Conservation regional office. The site includes many Natural Heritage Program sites: North Tivoli Bay Stony Creek, North Tivoli Bay, South Tivoli Bay, Tivoli Bays, North Bay Big Bend, Tivoli Bays Cruger Island, South Tivoli Bay Cruger Island, Tivoli Bays Cruger Island Neck, South Tivoli Bay Saw Kill.

## HABITAT PROTECTION MEASURES

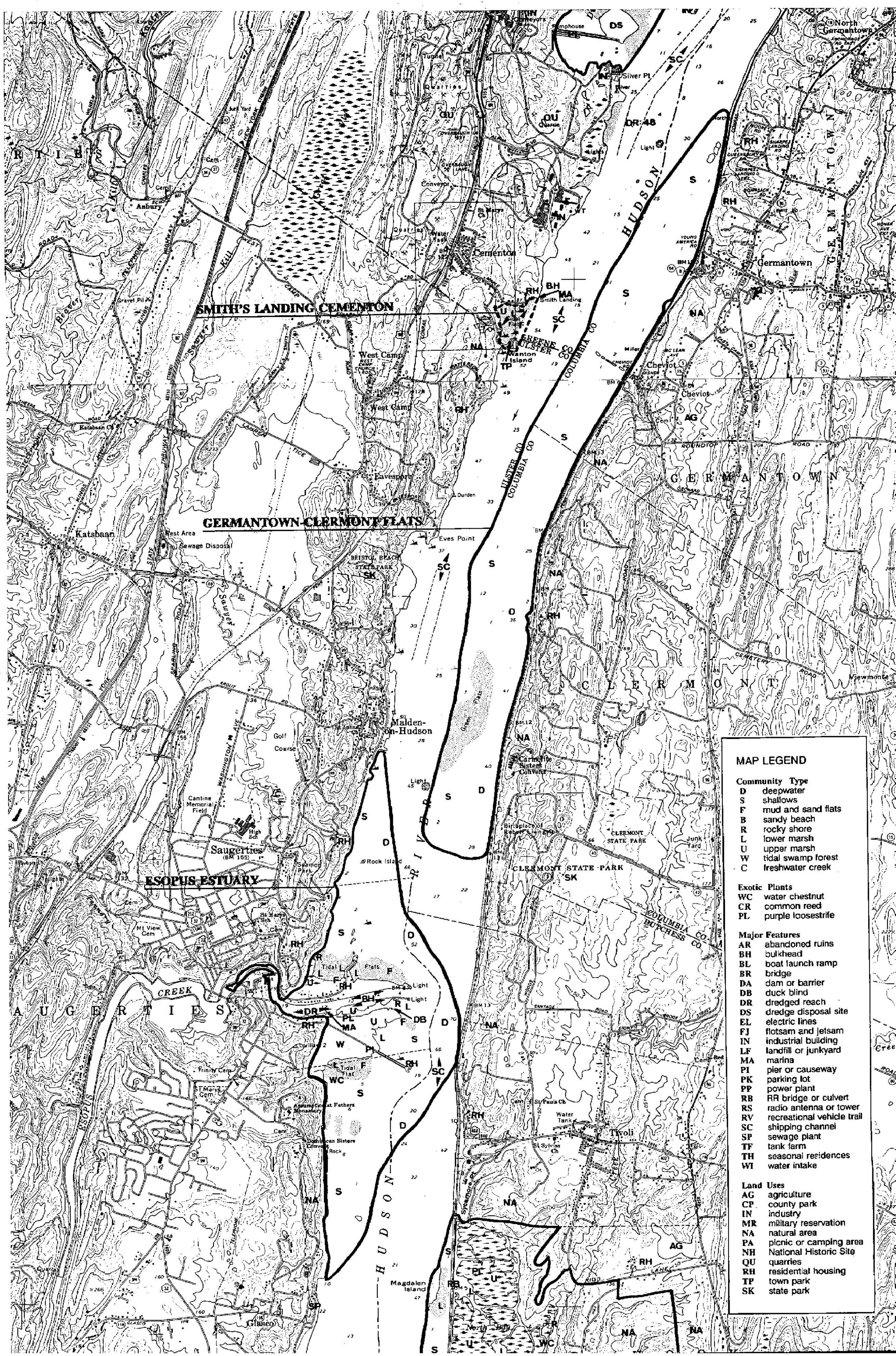
**Site Boundary:** Includes the entire designated Significant Coastal Fish and Wildlife Habitat area. Buffer zone should include most of the upland forest up to the crest of the bluff to the east.

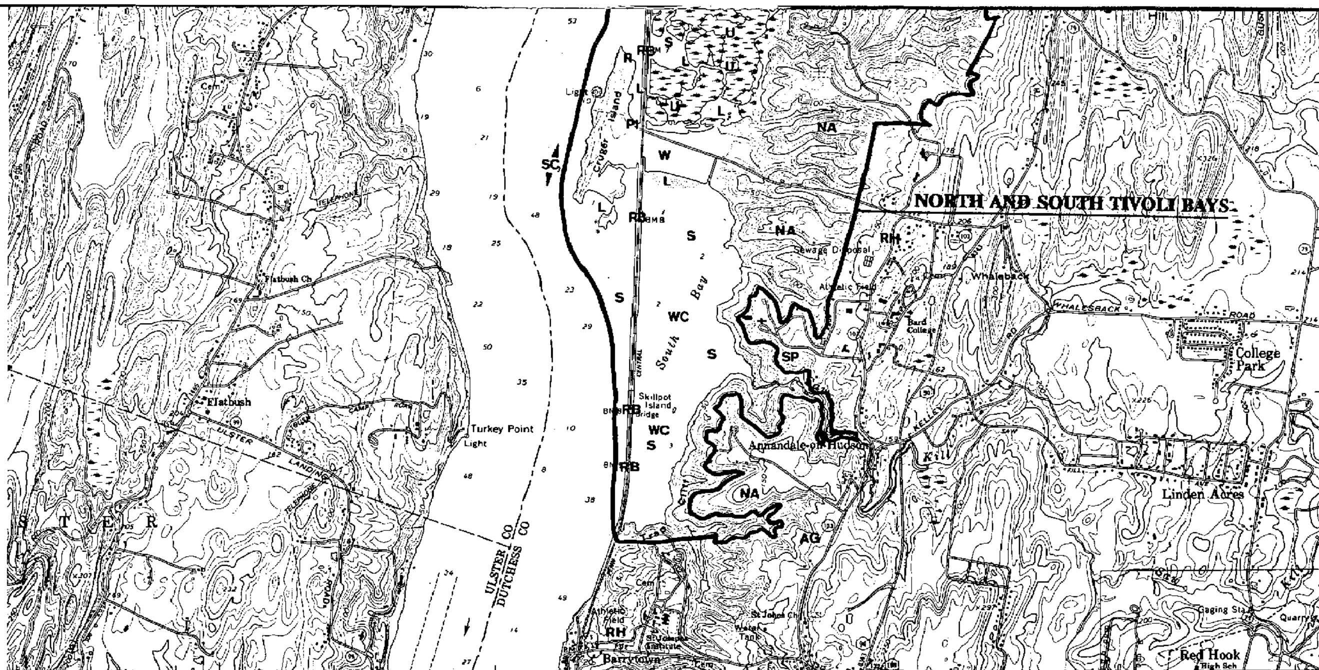
**Recommended Actions:** Monitor and control RR herbicides entering the habitat. Investigate protecting North Bay from water chestnut colonization by maintaining flows in channels through mechanical removal of invading water chestnut plants and controlling upland sediment sources. Facilitate access for research by maintaining small boating channels which should be maintained by mechanically clearing paths through the water chestnut. Protect both bays from oil spills by having booms available at each of the RR bridges. Ensure that runoff is not entering the habitats from the road to Cruger Island by maintaining grading and water bars. Consider allowing the Cruger Island causeway to revert from vehicle use to a pedestrian path for education and research uses. Maintain all buffer vegetation through appropriate landscape management (selective cutting and pruning). Include best management practices for all adjacent upland development to the extent that no increase in stormwater runoff will occur. Implement active erosion control through non-structural approaches (drainage and plantings) in areas prone to soil slumping. Ensure good management practices through land acquisition and conservation easements directed at protection of the immediate watershed. Institute watershed management programs for both creeks.

**Incompatible Use:** General motor boat traffic would disrupt wildlife and nature-oriented activities. (Small shallow draft boats are traditionally used in relatively low numbers to gain access for waterfowl hunting in the bays during fall months). Development or alterations in the site, including shoreline development along either bay to the top of the bluff. Any activity that would interfere with the habitat values of either of the two bays. Clearing buffer vegetation would increase non-point pollution and induce erosion and bank slumping.

**Recommended Use:** Increased use as an educational and research reserve. Facilitate access through construction of boardwalks and upgraded canoe launch sites as appropriate.

**Knowledgeable Contacts:** Tom Hart, DOS; Betsy Blair and Dennis Mildner (National Estuarine Research Reserve), Erik Kiviat (Hudsonia), DEC Region 3, Fisheries or Wildlife Manager or Environmental Protection Biologist.


SMITH'S LANDING-CEMENTON
GERMANTOWN-CLERMONT FLATS
ESOPUS ESTUARY
HUDSON
RIVER
GERMANTOWN
CLERMONT
SAUGERTIES
Cementon
Smith Landing
West Camp
Eavesport
Eves Point
Bristol Beach State Park
Malden-on-Hudson
Saugerties
Rock Island
Katsbaan
Asbury
Germantown
North Germantown
Cheviot
Silver Pt
Carmelite Sisters Convent
Clermont State Park
Tivoli
Magdalen Island
Glasco
Tidal Flats
GREENE CO
ULSTER CO
COLUMBIA CO
DUTCHESS CO
MAP LEGEND
Community Type
D deepwater
S shallows
F mud and sand flats
B sandy beach
R rocky shore
L lower marsh
U upper marsh
W tidal swamp forest
C freshwater creek
Exotic Plants
WC water chestnut
CR common reed
PL purple loosestrife
Major Features
AR abandoned ruins
BH bulkhead
BL boat launch ramp
BR bridge
DA dam or barrier
DB duck blind
DR dredged reach
DS dredge disposal site
EL electric lines
FJ flotsam and jetsam
IN industrial building
LF landfill or junkyard
MA marina
PI pier or causeway
PK parking lot
PP power plant
RB RR bridge or culvert
RS radio antenna or tower
RV recreational vehicle trail
SC shipping channel
SP sewage plant
TF tank farm
TH seasonal residences
WI water intake
Land Uses
AG agriculture
CP county park
IN industry
MR military reservation
NA natural area
PA picnic or camping area
NH National Historic Site
QU quarries
RH residential housing
TP town park
SK state park




**HUDSON RIVER TIDAL HABITATS** **MAP NUMBER 5**

**Smith's Landing Cementon / Germantown-Clermont Flats / Esopus Estuary / North and South Tivoli Bays**

Miles 0 ½ 1

N

New York State Department of State Division of Coastal Resources and Waterfront Revitalization

Prepared by T. Hart and N. Salafsky December 1989

## GEOGRAPHIC INFORMATION

REFER TO MAP NUMBER 6

**Site Name:** Mudder Kill
**Town(s):** Red Hook
**County(ies):** Dutchess
**7.5' Quad(s):** Kingston East

## BIOLOGICAL FEATURES

**Community Types:** Equal amounts of mudflats (F), lower marsh (L), upper marsh (U), and tidal swamp forest (W).
**Rare Species:** Goldenclub, hirsute sedge, Davis sedge, heavy sedge, kidney leaf mud-plantain, spongy arrowhead.

**Valuable Species:** None known.

**Sizes:** Small tracts of all habitats.

**Quality:** A *low* diversity habitat of *fair* quality that has experienced *limited* disturbance.

**Exotics:** Limited invasion of purple loosestrife.

**General Description:** A very small tidal cove west of the RR and a small swamp area east of the RR surrounded by steep upland areas and associated with the mouth of Mudder Kill.

## HUMAN INTERACTIONS

**Major Features:** Picnic area (PA), RR splits site in half.

**Site History:** Hydrological and sedimentation patterns in the site were greatly altered when the railroad was built in the 1850's.

**Existing Use:** Limited recreational day use of adjacent uplands.

**Surrounding Use:** Agricultural (AG), residential housing (RH).

**Status & Ownership:** Not a designated Significant Coastal Fish and Wildlife Habitat. Recognized by the NY Natural Heritage Program as containing rare tidal communities. Owned by Sylvania and by Rokeby Farms. The area wholly or partially includes State-regulated freshwater wetlands (KE-33). Refer to the official wetland maps available in the Department of Environmental Conservation regional office.

## HABITAT PROTECTION MEASURES

**Site Boundary:** The site boundary shown is from the NY Natural Heritage Program records. Buffer zone should include the steep bluffs surrounding Mudder Kill.

**Recommended Actions:** Conduct detailed surveys and monitor stability of rare communities. The tidal cove may benefit from increased tidal circulation. Limit herbicide use in association with the RR to avoid impacts on rare plants.

**Incompatible Use:** Any direct use of the site would destroy the rare communities. Boating access. Dredging, filling or increasing sedimentation.

**Recommended Use:** None identified.

**Knowledgeable Contacts:** Tom Hart, DOS; DEC Region 3, Fisheries or Wildlife Manager or Environmental Protection Biologist. Erik Kiviat, Hudsonia, Inc. Carol Reschke and Caryl Devries, The Nature Conservancy

## GEOGRAPHIC INFORMATION

**Site Name:** The Flats
**Town(s):** Ulster, Kingston, Red Hook, Rhinebeck
**County(s):** Ulster, Dutchess
**7.5' Quad(s):** Kingston East

REFER TO MAP NUMBER 6

## BIOLOGICAL FEATURES

**Community Types:** Comprised entirely of shallows (S).

**Rare Species:** Potential shortnose sturgeon feeding and resting area.

**Valuable Species:** Primary spawning grounds for American shad. Spawning and nursery grounds for striped bass, white perch, resident fishes. Significant feeding areas during migration periods for diving ducks and resting areas for all duck species.

**Size:** A very large expanse of shallows stretching for 4.5 miles along the middle of the River.

**Quality:** A *uniform* habitat of *excellent* quality that has experienced *moderate* disturbance.

**Exotics:** None identified.

**General Description:** A large underwater ridge system, most of which is shallow River bottom covered with aquatic plants. Occasional deeper water areas.

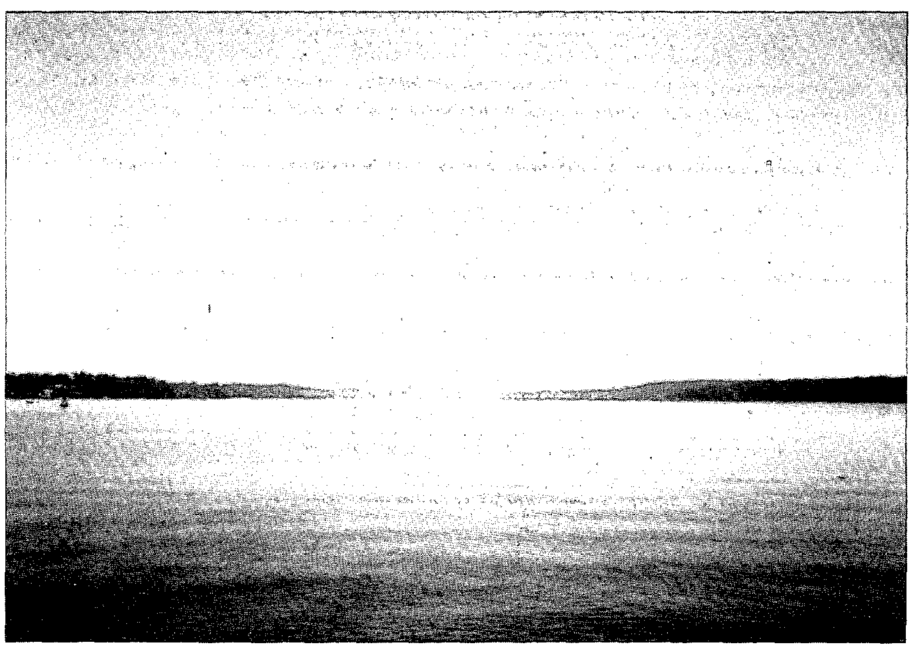


*Figure 49: View of The Flats looking north. Photo by Nancy Nugent/DOS*

## HUMAN INTERACTIONS

**Major Features:** Shipping channel (SC), Kingston-Rhinecliff Bridge (BR).

**Site History:** The River channel was first dredged in the 1930's with maintenance dredging occurring subsequently. The Kingston-Rhinecliff Bridge was constructed in 1957.

**Existing Use:** Recreational boat traffic, recreational fishing. Commercial shad fishing is prohibited based on the importance of the site for maintaining shad stocks.

**Surrounding Use:** Residential housing (RH), agriculture (AG), villages, quarries (QU), natural areas (NA).

**Status:** Designated as a Significant Coastal Fish and Wildlife Habitat. The site includes the Natural Heritage Program's The Flats site.

## HABITAT PROTECTION MEASURES

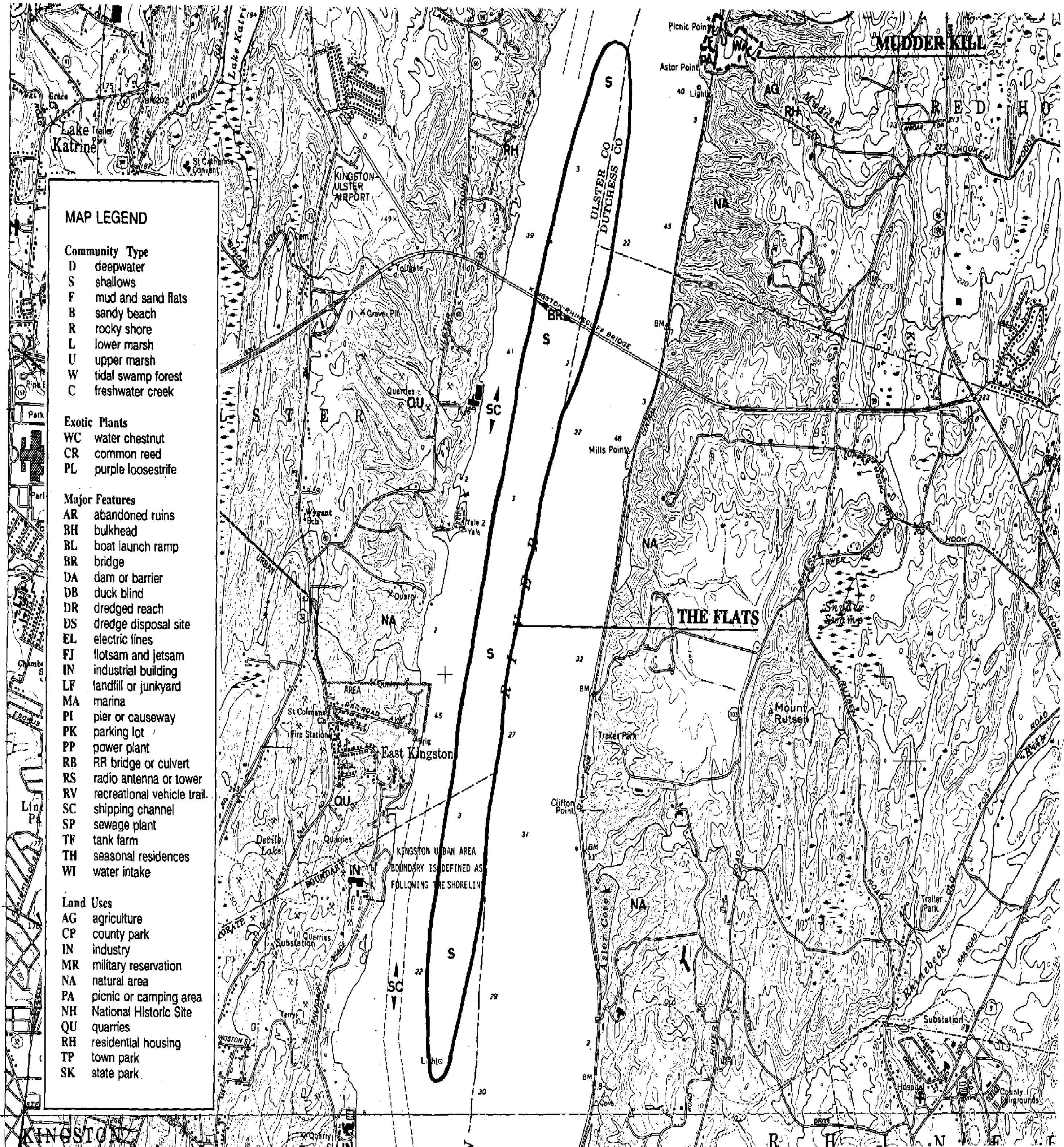
**Site Boundary:** Includes the entire designated Significant Coastal Fish and Wildlife Habitat area. The buffer zone is unique in that it includes all adjacent sections of the River itself, since the area's value depends on overall water quality.

**Recommended Actions:** Restrict dredging of the channel to late summer or mid to late winter to avoid disrupting the fish and bird uses of the area. Recreational boat use over the shallow water areas should ideally be restricted and directed over deeper waters, especially during fish spawning and waterfowl feeding times. Continue efforts to improve the overall water quality of the River. The area should be used as a research reserve and as a sanctuary with limited non-resource related recreational use. Establish bridge maintenance practices to control entry of runoff from the bridge and associated interchanges and to limit entry of maintenance debris such as paint and sand-blasting materials.

**Incompatible Use:** Dredging activity during the spring and fall waterfowl migration periods or during the spring or early summer fish spawning times. New navigation channels or dredge disposal. Marinas and other development that would result in boating traffic patterns in the shallows. Loss of habitat due to bridge maintenance or construction.

**Recommended Use:** Increased recreational fishing.

**Knowledgeable Contacts:** Tom Hart, DOS; William Dovel; Fisheries or Wildlife Manager or Environmental Protection Biologists in DEC Region 3.




# HUDSON RIVER TIDAL HABITATS

## MAP NUMBER 6

### Mudder Kill / The Flats

Miles

0 ½ 1

N

New York State Department of State Division of Coastal Resources and Waterfront Revitalization

Prepared by T. Hart and N. Salafsky December 1989

GEOGRAPHIC INFORMATION

REFER TO MAP NUMBER 7

**Site Name:** Rondout Creek
**Town(s):** Kingston, Esopus, Ulster
**County(ies):** Ulster
**7.5' Quad(s):** Kingston East, Kingston West

BIOLOGICAL FEATURES

**Community Types:** Predominantly creek (C) with shallows (S), mudflats (F), rocky shore (R), lower marsh (L), and limited amounts of upper marsh (U) in association with the creek mouth.

**Rare Species:** Heart leaf plantain. Osprey during spring migration.

**Valuable Species:** Important spawning areas for anadromous fish including alewife, rainbow smelt, blueback herring, white perch, tomcod, striped bass, and American shad. Important for resident fish including brown bullhead, yellow perch, sunfish, and black basses. Limited use by migrating waterfowl for resting and feeding. Extensive feeding on the mudflats by herons and other wading birds.

**Size:** Large mudflats, medium to large areas of marsh and shallow water, four miles of unobstructed creek that drains over 1100 square miles in Ulster County.

**Quality:** A *moderately* diverse habitat of *fair* quality that has experienced *extensive* disturbance.

**Exotics:** Moderate to heavy invasions of water chestnut (WC), common reed (CR), and purple loosestrife (PL).

**General Description:** A large site that has undergone considerable alteration as a result of human activities. Rondout Creek is a large, medium gradient, warmwater stream with a deep silt and clay bottom that is tidally influenced for most of the four mile unobstructed reach. South of the creek mouth is a large mudflats and marsh area known as Sleightsburg Marsh.

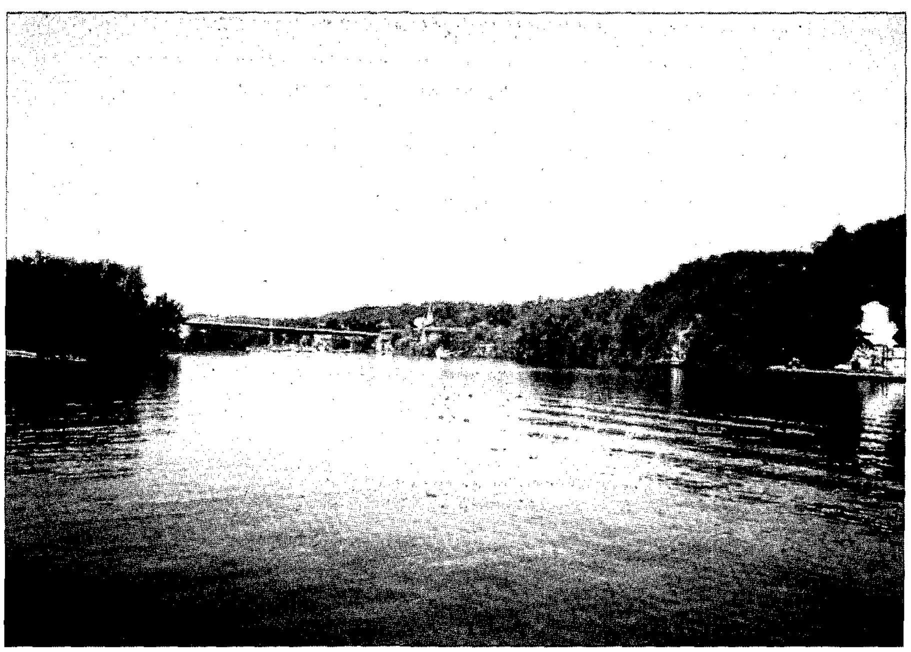


*Figure 50: Near the mouth of Rondout Creek, looking west. Photo by Nancy Nugent/DOS*

## HUMAN INTERACTIONS

**Major Features:** The City of Kingston, extensive bulkheading (BH), marinas (MA), town parks and beach (TP), tank farm (TF), dredging in the creek (DR), dredge spoil islands (DS), sewage plant (SP), landfill area and junkyard (LF), small tourist RR, dam on the creek (DA). Significant water withdrawal from the creek further upstream.

**Site History:** The creek was dredged in 1935 and 1968. The harbor has been the site of much commercial activity over the past two centuries. Creek flow is regulated at the dam in Eddyville near Route 213.

**Existing Use:** Area of concentrated recreational boating. Moderate fishing and waterfowl hunting. Intake of over 200 cubic feet per second of water from upper portions of Rondout Creek. Tourist railroad and picnic area at the end of the small causeway. SPDES waste discharge permits were held in the early 1980's by Hercules Inc., Kingston Oil Supply Corp. (3 terminals), Motzbro Corp., and the Kingston Sewage District. Barge traffic within the Creek.

**Surrounding Use:** Kingston urban area, residential housing (RH), industry (IN), quarries (QU).

**Status:** Designated as a Significant Coastal Fish and Wildlife Habitat. The area wholly or partially includes State-regulated freshwater wetlands (KE-4, KE-11). Refer to the official wetland maps available in the Department of Environmental Conservation regional office. The site includes the Natural Heritage Program's Roundout Creek Mouth site.

## HABITAT PROTECTION MEASURES

**Site Boundary:** Includes the entire Significant Coastal Fish and Wildlife Habitat area. The buffer zone should include the remaining wooded uplands along the banks of the Creek above Kingston and the developed lands immediately adjacent to the Creek within Kingston. The boundary of the designated significant habitat extends up the creek beyond what is shown on the map.

**Recommended Actions:** Monitor and protect against spills and leakage of pollutants from surrounding industry and landfill areas. Potential spillage from the fuel tanks to the north should receive particular attention. Preclude picnic area users from trampling heart leaf plantain along the shore with exclosures. Develop wetlands education displays to enhance visits to the site and provide needed education in this densely populated area. Study effects of increasing circulation in the shallows and flats by allowing controlled flow through the channel bulkheads. Establish advanced stormwater and non-point pollution control programs in the City. Eliminate existing direct discharges of sewage into the Creek from adjacent residences. Introduce vegetated and permeable buffers in conjunction with paved and developed areas adjacent to the Creek to reduce direct runoff.

**Incompatible Use:** Dredging or development that would alter or destroy shallows, flats or marsh. Further restriction of tidal flow. Substantial reduction of freshwater flow in the creek. Dredging activities during spring and early summer when most fish are spawning and in December and January when tomcod are active. Hydroelectric development at the Eddyville dam with the exception of run-of-the-river power generation. Construction, clearing or other activities that would increase runoff to and sediment in the Creek.

**Recommended Use:** Environmental education concerning tidal wetlands, increased fishing, bird watching.

**Knowledgeable Contacts:** Tom Hart, DOS; DEC Region 3, Fisheries or Wildlife Manager or Environmental Protection Biologist.

GEOGRAPHIC INFORMATION

**Site Name:** Kingston Deepwater
**Town(s):** Rhinebeck, Hyde Park, Esopus
**County(s):** Dutchess, Ulster
**7.5' Quad(s):** Hyde Park, Kingston East

REFER TO MAP NUMBER 7

BIOLOGICAL FEATURES

**Community Types:** Deepwater (D).

**Rare Species:** Shortnose sturgeon wintering area and possible spawning grounds.

**Valuable Species:** Atlantic sturgeon wintering area, the northern extent of many marine fishes in the Hudson.

**Size:** Very large deepwater area extending over six miles of the River.

**Quality:** A *uniform* habitat of *excellent* quality that has experienced *limited* disturbance.

**General Description:** A nearly continuous deepwater section of the River with bottom depths between 30 and 100 feet. Dense saline waters introduced by the tidal salt wedge lie in this deep trough and provide a unique environment for many estuarine and marine species that would not tolerate the overlying freshwater.

*Figure 51: The Kingston Deepwater area from Norrie Point. Photo by Nancy Nugent/DOS*

## HUMAN INTERACTIONS

**Major Features:** Shipping channel (SC).

**Site History:** None recorded.

**Existing Use:** Shipping traffic in overlying waters. Treated sewage discharge near upper depth limit of habitat.

**Surrounding Use:** Residential housing (RH), the City of Kingston, villages, agricultural areas (AG), Norrie State Park (SK), natural areas (NA).

**Status:** Designated as a Significant Coastal Fish and Wildlife Habitat. The site includes the Natural Heritage Program's Kingston Deepwater site.

## HABITAT PROTECTION MEASURES

**Site Boundary:** Includes the entire designated Significant Coastal Fish and Wildlife Habitat area. The boundary parallels the River shore along the 30 foot depth contour. The buffer zone is the overlying water column and adjacent portions of the River itself.

**Recommended Actions:** River-wide water quality improvements including reducing sedimentation in the area should continue. Large scale hydrodynamic studies including salt wedge dynamics are essential in understanding the function and importance of this habitat.

**Incompatible Use:** Dredge spoil disposal. Large scale water withdrawals that would alter the chemical characteristics and the seasonal patterns associated with this habitat. Discharges directly into the deep water trough.

**Recommended Use:** None identified.

**Knowledgeable Contacts:** Tom Hart, DOS; DEC Region 3, Fisheries Manager or Environmental Protection Biologist.

## GEOGRAPHIC INFORMATION

**Site Name:** Vanderburgh Cove and Shallows

REFER TO MAP NUMBER 7

**Town(s):** Rhinebeck, Hyde Park
**County(ies):** Dutchess
**7.5' Quad(s):** Kingston East, Hyde Park

## BIOLOGICAL FEATURES

**Community Types:** Largely shallows (S) with smaller amounts of mudflats (F), lower marsh (L), upper marsh (U), tidal swamp (W), and freshwater creek (C).

**Rare Species:** Possible shortnose sturgeon feeding grounds, osprey feeding ground during migration, sharp-winged monkey flower.

**Valuable Species:** Extensive waterfowl feeding and resting grounds during spring and fall migrations. Important spawning, nursery, and feeding grounds for anadromous fish (striped bass, American shad, white perch, rainbow smelt, alewife, blueback herring) and resident fish (largemouth bass, yellow perch, brown bullhead).

**Size:** Medium to large sized wetland. Large shallows area. Access for river fish extends up Landsman Kill and Fallsburg Creek.

**Quality:** A *moderately* diverse habitat of *good* quality that has experienced *moderate* disturbance.

**Exotics:** Extensive invasion of the cove by water chestnut (WC), limited invasion of the fringes by purple loosestrife.

**General Description:** Vanderburgh Cove is a large shallow water area with some lower and upper marsh area near the mouths of the two tributary streams that are tidal for at least one-half mile upstream. There is a small area of some swamp forest along Fallsburg Creek. The site also includes Suckley Cove, a smaller version of Vanderburgh Cove located to the north which is an excellent quality lower marsh that has experienced limited disturbance. A large expanse of shallows exists to the west of the RR track with a silt substrate and beds of aquatic vegetation.

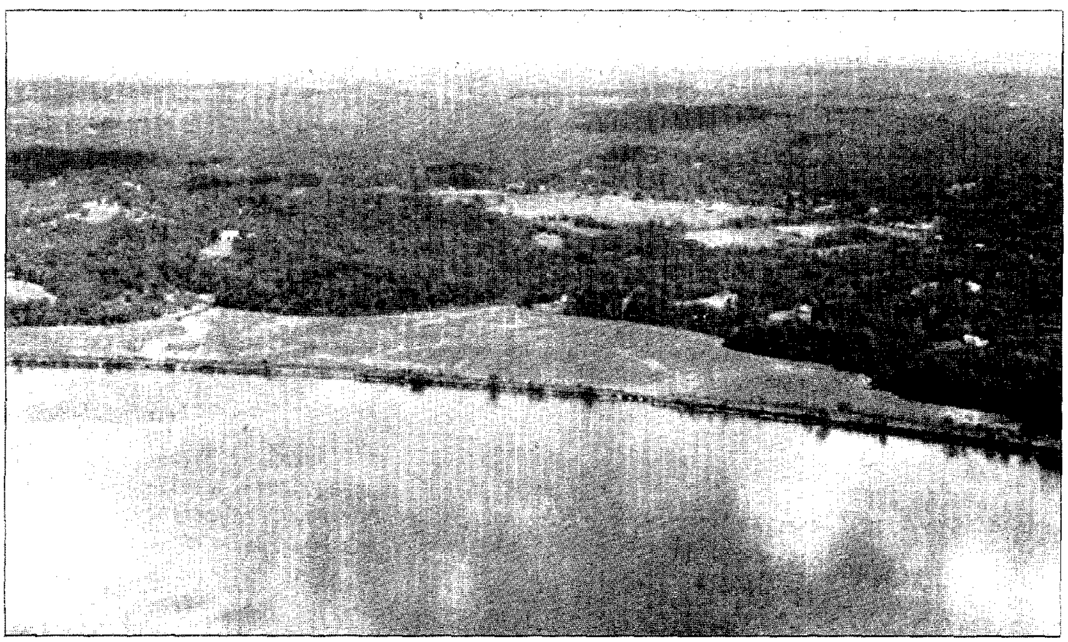


*Figure 52: Aerial view of Vanderburg Cove looking east. Photo by Harry Dodson/Dodson Associates*

## HUMAN INTERACTIONS

**Major Features:** The RR with two bridges (RB) in Vanderburgh cove and one in Suckley Cove, residential housing (RH), nearby roads and bridges over the creeks, sewage discharge (SP) on Landsman Kill.

**Site History:** Hydrological and sedimentation patterns in the site were greatly altered when the railroad was built in the 1850's. One of the two RR bridges was reconstructed in 1980 and further restricted water flow with a smaller channel width; this may have been detrimental to the overall value of the cove.

**Existing Use:** Extensive waterfowl hunting and recreational fishing. A SPDES waste discharge permit was held in the early 1980's by Orchard Hill Farms of Red Hook which discharged into Landsman Kill.

**Surrounding Use:** Residential housing (RH), natural areas (NA).

**Status:** Designated as a Significant Coastal Fish and Wildlife Habitat. The area wholly or partially includes State-regulated freshwater wetlands (KE-29, HP-31). Refer to the official wetland maps available at the Department of Environmental Conservation regional office. The site includes the Natural Heritage Program's Vanderburgh Cove site.

## HABITAT PROTECTION MEASURES

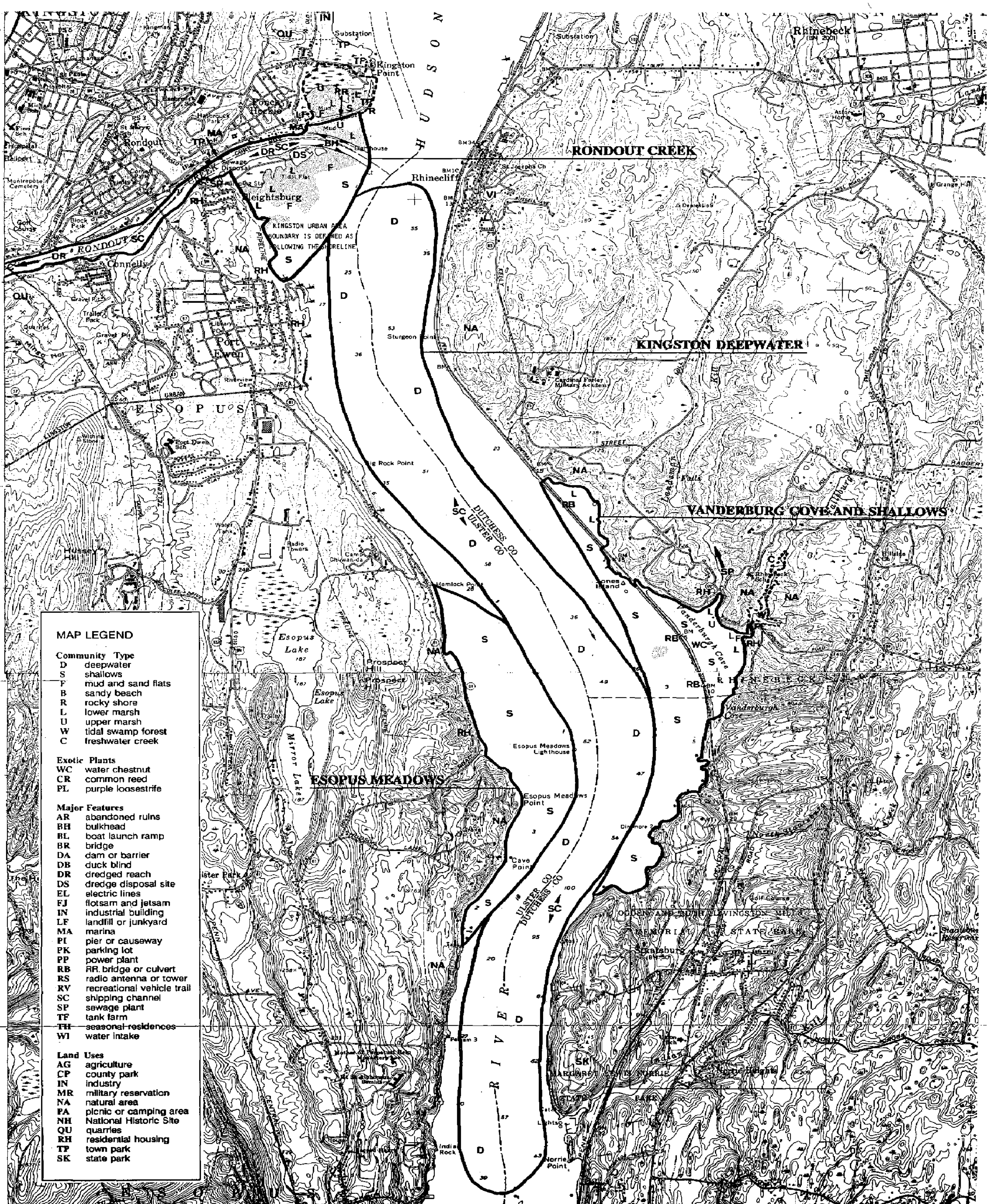
**Site Boundary:** Includes the entire designated Significant Coastal Fish and Wildlife Habitat area. The site boundary should be expanded to include the small unobstructed portion of Landsman Kill and its associated swamp. The buffer zone should include the wooded slopes on the eastern shore extending to the top of the banks along the two streams.

**Recommended Actions:** Eliminate herbicide runoff associated with the RR right of way. Maintain the vegetation cover surrounding the site. Institute watershed management programs for the two Creeks. Reduce boating traffic over the shallows and flats.

**Incompatible Use:** Dredging or development that would result in the loss of habitat. Further reduction in the tidal flushing of the coves. Marinas or other development that would result in boating traffic through the shallows and flats. Any disturbance of shoreline or vegetation in or adjacent to Suckley Cove that may result in the introduction of exotics in this high quality area.

**Recommended Use:** Increased fishing.

**Knowledgeable Contacts:** Tom Hart, DOS; William Dovel. DEC Region 3, Fisheries or Wildlife Manager or Environmental Protection Biologist. Erik Kiviat, Hudsonia, Inc.




**HUDSON RIVER TIDAL HABITATS** **MAP NUMBER 7**

**Rondout Creek / Kingston Deepwater / Vanderburg Cove and Shallows / Esopus Meadows**

Miles
0 ½ 1

N

New York State Department of State Division of Coastal Resources and Waterfront Revitalization

Prepared by T. Hart and N. Salafsky December 1989

## GEOGRAPHIC INFORMATION

**Site Name:** Esopus Meadows
**Town(s):** Esopus
**County(ies):** Ulster
**7.5' Quad(s):** Kingston East, Hyde Park

REFER TO MAP NUMBERS 8A & 8B

## BIOLOGICAL FEATURES

**Community Types:** Shallows (S)

**Rare Species:** Important feeding area for shortnose sturgeon, especially in the spring.

**Valuable Species:** Spawning, nursery, and feeding for anadromous fishes including striped bass, American shad, and white perch. Important feeding areas for resident fishes including largemouth bass, yellow perch, brown bullhead, and shiners. Use as a feeding and resting area by waterfowl during spring and fall migrations.

**Size:** A large expanse of shallow water.

**Quality:** A *uniform* habitat of *good* quality that has experienced *limited* disturbance.

**Exotics:** None noted.

**General Description:** A large shoal area in the River with shallow water beds dominated by aquatic vegetation.

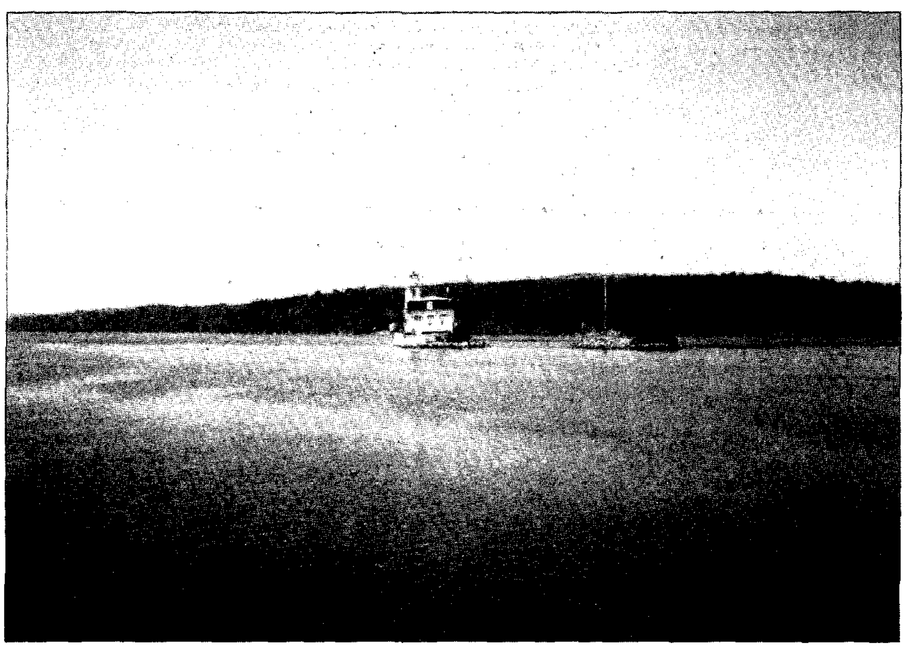


*Figure 53: Esopus Meadows looking south. Photo by Nancy Nugent/DOS*

## HUMAN INTERACTIONS

**Major Features:** Shipping channel (SC).

**Site History:** None identified.

**Existing Use:** Extensive recreational fishing, waterfowl hunting, and bird watching. Intense local recreational use of the Riverbank adjacent to Route 81.

**Surrounding Use:** Residential housing (RH), natural areas (NA).

**Status:** Designated as a Significant Coastal Fish and Wildlife Habitat. The site includes the Natural Heritage Program's Esopus Meadows site.

## HABITAT PROTECTION MEASURES

**Site Boundary:** Includes the entire designated Significant Coastal Fish and Wildlife Habitat area. The buffer zone should include wooded upland up to the crest of the steep banks to the south and the banks along Route 81 to the north.

**Recommended Actions:** Restrict recreational motorboat traffic in the area during spring and fall when fish and wildlife use of this habitat is vulnerable to human activity. Re-establish vegetation in selected high use areas along Route 81.

**Incompatible Use:** Cutting any navigation channels. Extensive non-resource related motorboat traffic especially during waterfowl migration and fish spawning periods. Marina development.

**Recommended Use:** Increased fishing.

**Knowledgeable Contacts:** Tom Hart, DOS; William Dovel. DEC Region 3, Fisheries or Wildlife Manager or Environmental Protection Biologist.

GEOGRAPHIC INFORMATION

**Site Name:** Poughkeepsie Deepwater — REFER TO MAP NUMBERS 8A & 8B
**Town(s):** Hyde Park, Poughkeepsie, Wappinger, Esopus, Lloyd, Marlboro
**County(ies):** Dutchess, Ulster
**7.5' Quad(s):** Hyde Park, Poughkeepsie, Wappingers Falls.

BIOLOGICAL FEATURES

**Community Types:** Deepwater (D).

**Rare Species:** Shortnose sturgeon wintering area and possible nursery grounds.

**Valuable Species:** Estuarine and marine fish including bay anchovies, silversides, bluefish, weakfish, and hogchokers.

**Size:** A vast site containing 14 miles of the River.

**Quality:** A *uniform* habitat of *excellent* quality that has experienced *limited* disturbance.

**Exotics:** None noted.

**General Description:** A nearly continuous deepwater section of the River with bottom depths between 30 and 100 feet. Dense saline waters introduced by the tidal salt wedge lie in this deep trough and provide a unique environment for many estuarine and marine species that would not tolerate the overlying freshwater.

*Figure 54: View to north of the Poughkeepsie Deepwater area. Photo by Steve Stanne/Clearwater*

## HUMAN INTERACTIONS

**Major Features:** Shipping channel (SC), Mid-Hudson Bridge (BR), sewage plants (SP), water intakes (WI), tank farms (TF).

**Site History:** The site has been used for deepwater dredge disposal.

**Existing Use:** Shipping traffic in overlying waters. Treated sewage discharge near upper depth limit of habitat. SPDES waste discharge permits were held in the early 1980's by Alfa Laval Inc., J.R. Sousa and Sons, Love Oil Corp., Tau Laboratories, Western Publishing Co., Agway Petroleum Corp., Hudson Valley Apple Prod. Inc., and the City of Poughkeepsie Sewage District.

**Surrounding Use:** Poughkeepsie urban area , villages , industry (IN), residential housing (RH), quarries (QU), FDR National Historic Site (NH), natural areas (NA).

**Status & Ownership:** Designated as a Significant Coastal Fish and Wildlife Habitat. The site includes the Natural Heritage Program's Poughkeepsie Deepwater site.

## HABITAT PROTECTION MEASURES

**Site Boundary:** Includes the entire designated Significant Coastal Fish and Wildlife Habitat area. The boundary parallels the River shore along the 30 foot depth contour. The buffer zone is the overlying water column and adjacent portions of the River itself.

**Recommended Actions:** Improve River-wide water quality including reducing sedimentation in the area. Study large scale River hydrodynamics, including salt wedge dynamics, to further an understanding of the function and importance of this habitat.

**Incompatible Use:** Dredge disposal. Large scale water withdrawals that would alter the chemical characteristics and the seasonal patterns associated with this habitat. Discharges directly into the deep water trough.

**Recommended Use:** None identified.

**Knowledgeable Contacts:** Tom Hart, DOS; DEC Region 3, Fisheries Manager or Environmental Protection Biologist.

## GEOGRAPHIC INFORMATION

**Site Name:** Crum Elbow Marsh
**Town(s):** Hyde Park
**County(ies):** Dutchess
**7.5' Quad(s):** Hyde Park

REFER TO MAP NUMBER 8A

## BIOLOGICAL FEATURES

**Community Types:** Small amount of shallows (S), lower marsh (L), upper marsh (U), tidal swamp forest (W).

**Rare Species:** Map turtle population.

**Valuable Species:** Waterfowl migration use but value is limited by size of the marsh.

**Size:** Small areas of marsh and shallows.

**Quality:** A *moderately* diverse habitat of *good* quality that has experienced *limited* disturbance.

**Exotics:** None noted.

**General Description:** A small tidal cove fronted by the RR with shallows grading into lower marsh and a small area of swamp forest extending along the tributary creek.

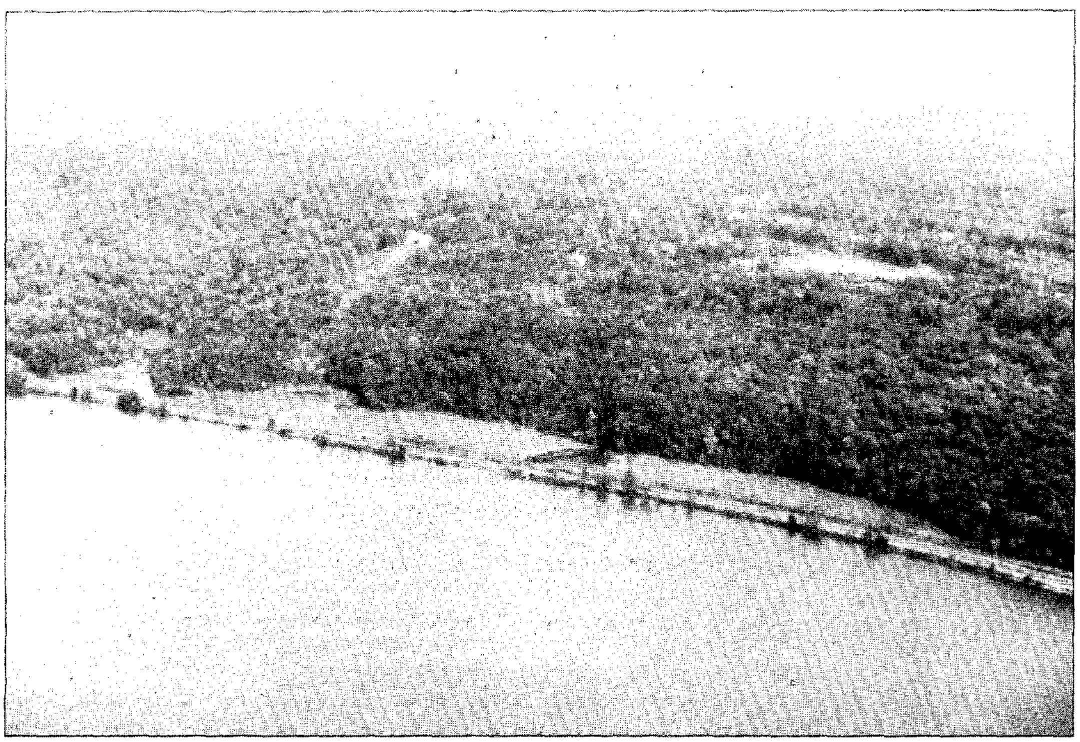


*Figure 55: Aerial view of Crum Elbow Marsh looking east. Photo by Harry Dodson/Dodson Associates*

## HUMAN INTERACTIONS

**Major Features:** The railroad with one bridge (RB). Site is also known as Roosevelt Cove.

**Site History:** Hydrological and sedimentation patterns in the site were greatly altered when the railroad was built in the 1850's.

**Existing Use:** None noted.

**Surrounding Use:** FDR National Historic Site (NH), natural areas (NA).

**Status:** Not a designated Significant Coastal Fish and Wildlife Habitat. Recognized by the NY Natural Heritage Program as containing rare tidal communities. The Federal government owns the FDR National Historic Site which contains most of the habitat. The area wholly or partially includes State-regulated freshwater wetlands (HP-36). Refer to the official wetland maps available at the Department of Environmental Conservation regional office.

## HABITAT PROTECTION MEASURES

**Site Boundary:** Boundaries shown on the map are from the NY Heritage Program site. Buffer zone should include the adjacent vegetated slopes and the FDR National Historic Site.

**Recommended Actions:** Investigate possibilities of increasing tidal flow into the cove. Limit RR herbicides entering the tidal environment. Promote the use of this site as a scientific research model since the majority of the habitat's watershed is protected.

**Incompatible Site Uses:** Any activity that would reduce tidal flow into the area. Introduction of sediment and pollutants through clearing and grounds maintenance.

**Recommended Use:** Access to site and the River via a hiking trail.

**Knowledgeable Contacts:** Tom Hart, DOS; David Hayes, FDR National Historic Site. DEC Region 3, Fisheries or Wildlife Manager or Environmental Protection Biologist. Erik Kiviat, Hudsonia, Inc. Robert Zaremba, The Nature Conservancy.

## GEOGRAPHIC INFORMATION

**Site Name:** Wappinger Creek
**Town(s):** Poughkeepsie, Wappinger
**County(ies):** Dutchess
**7.5' Quad(s):** Wappingers Falls

REFER TO MAP NUMBER 8B

## BIOLOGICAL FEATURES

**Community Types:** Predominantly creek (C) with smaller amounts of shallows (S), mudflats (F), lower marsh (L), and upper marsh (U).

**Rare Species:** Osprey feeding during spring migrations. Grassleaf arrowhead, subulate arrowhead, kidney leaf mud plantain and Maryland bur-marigold.

**Valuable Species:** Important spawning areas for anadromous fishes including alewife, blueback herring, white perch, tomcod, and striped bass. Many resident fish species including largemouth bass, bluegill, brown bullhead, and red-breasted sunfish. Productive feeding area for herons, waterfowl, and turtles.

**Size:** Medium sized shallows, marsh, and mudflat. Tidal influence extends two miles up the creek.

**Quality:** A *low* diversity habitat of *fair* quality that has experienced *extensive* disturbance.

**Exotics:** Extensive invasion by water chestnut (WC).

**General Description:** The creek itself is a large, perennial, warmwater stream containing mudflats, sandbars, and shallow water within the tidal portion. There are small areas of marsh near the mouth of the creek and west of the RR tracks there is an area of shallow water in the River itself. The creek and its mouth are heavily covered with water chestnut.

*Figure 56: Wappinger Creek looking east.*

## HUMAN INTERACTIONS

**Major Features:** Road and railroad crossings (RB), dredged channel in the creek (DR), residential boat launches (BL), marina (MA), fishing pier (PI), dam (DA), sewage plant (SP), tank farm (TF), power plant (PP), water intake (WI).

**Site History:** Hydrological and sedimentation patterns in the site were greatly altered when the railroad was built in the 1850's. The creek was dredged in 1922, 1930, and 1939. Extensive commercial and industrial use along creek in Wappingers Falls. Water flow in the Creek is controlled by the dam in Wappingers Falls.

**Existing Use:** Limited boating access, fishing, crabbing, water intake upstream. Boat use of the creek is currently limited by the 6 months' advance notice required for rail drawbridge operation. SPDES waste discharge permits were held in the early 1980's by institutions along Wappingers Creek as far upstream as Millbrook including P.J. Haight and Co., Dutchess Quarry and Supply Co., IBM Corp., Fairchild Corp., New York Trap Rock Corp., and the Wappingers Falls Sewage District.

**Surrounding Use:** Wappingers Falls urban area, villages, residential housing (RH), natural areas (NA).

**Status:** Designated as a Significant Coastal Fish and Wildlife Habitat. The site includes the NY Natural Heritage Program's Wappinger's Creek Mouth site.

## HABITAT PROTECTION MEASURES

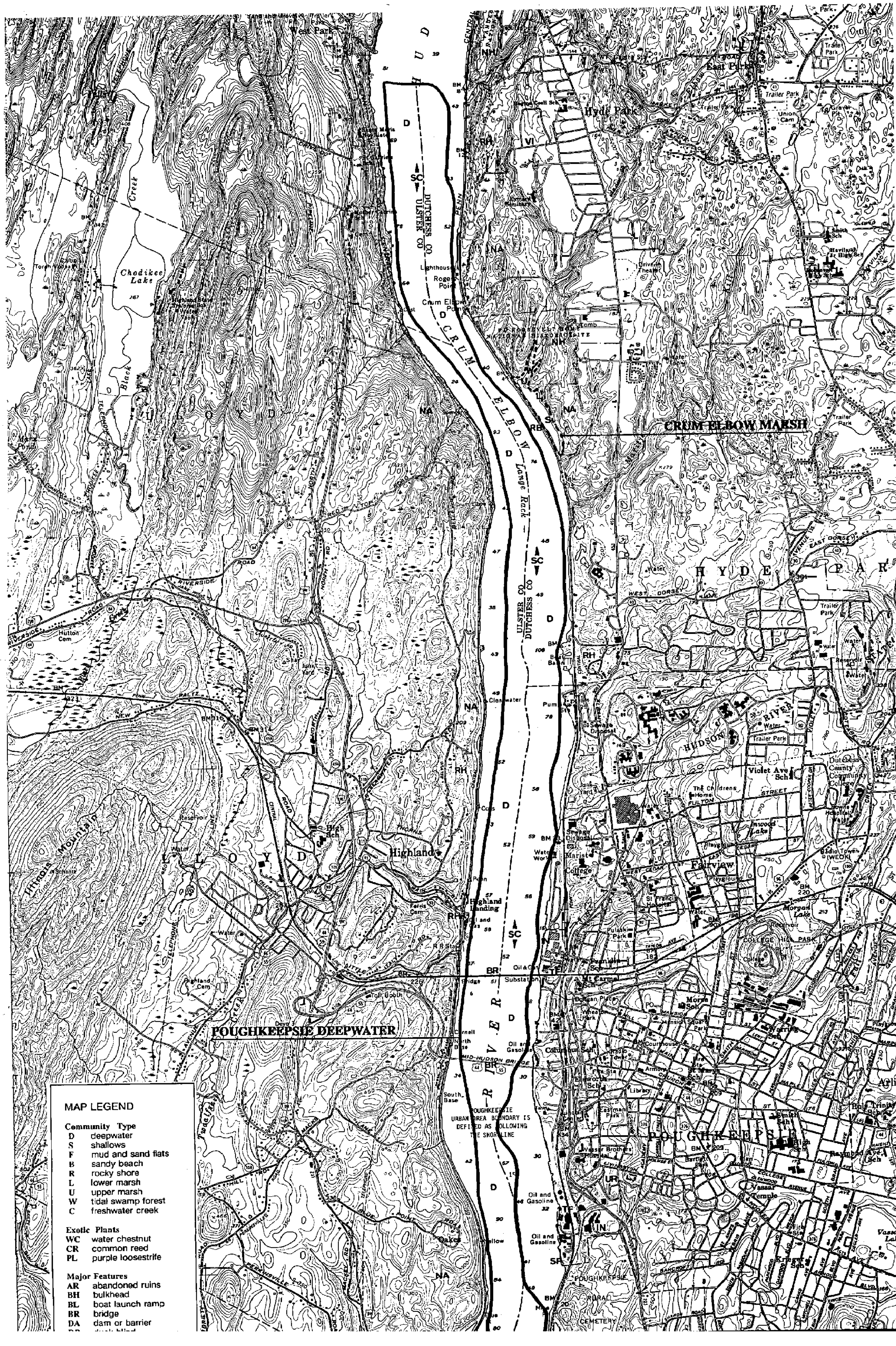
**Site Boundary:** Includes the entire designated Significant Coastal Fish and Wildlife Habitat area. The buffer zone should include the steep wooded uplands on both sides of the creek.

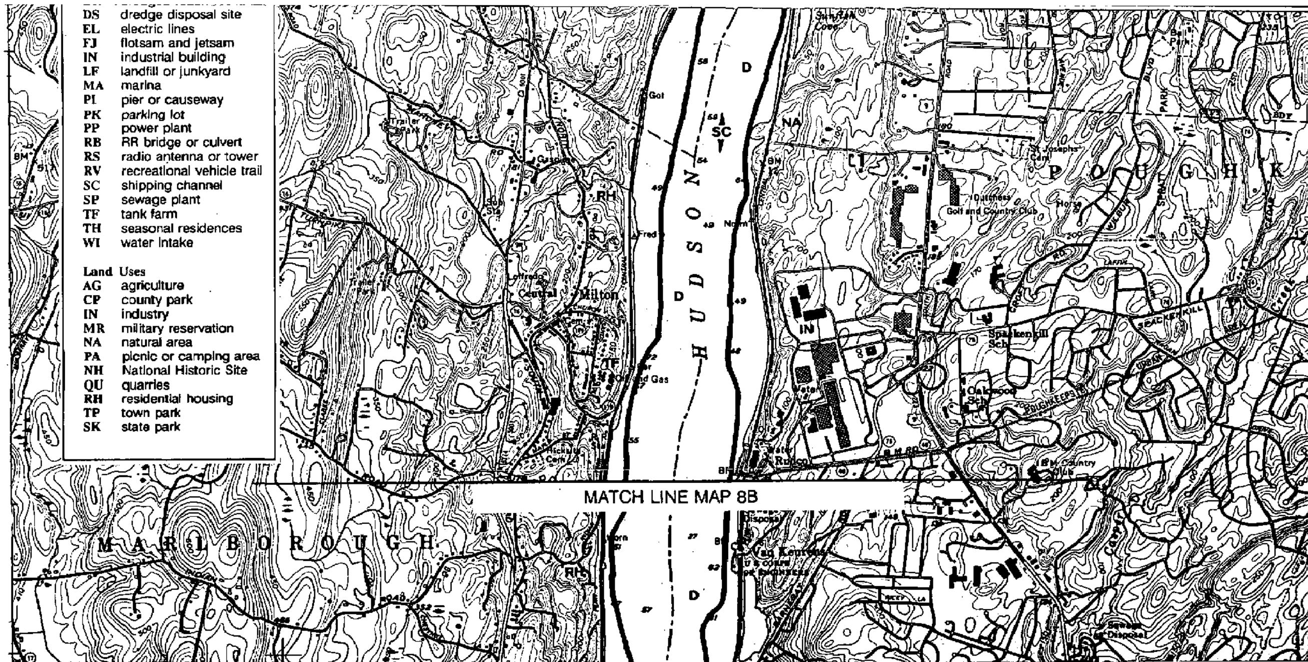
**Recommended Actions:** Monitor and control runoff from nearby highways. Maintain bank vegetation. Institute advanced stormwater and non-point source pollution control programs in the urban and residential areas.

**Incompatible Use:** Dredging the channel during fish reproductive periods including spring and early summer (most species) and December and January (tomcod). Excessive noise and activity during the osprey migration in mid-April to May. Significant water withdrawal that will reduce flow in the creek, especially during critical breeding times. Marina development.

**Recommended Use:** Increased fishing.

**Knowledgeable Contacts:** Tom Hart, DOS; DEC Region 3, Fisheries or Wildlife Manager or Environmental Protection Biologist.


CRUM ELBOW MARSH
POUGHKEEPSIE DEEPWATER
HUDSON RIVER
CRUM ELBOW
Lange Rack
DUTCHESS CO
ULSTER CO
LLOYD
HYDE PARK
POUGHKEEPSIE
West Park
Hyde Park
East Park
Chodikee Lake
Highland
Highland Landing
Fairview
Illinois Mountain
POUGHKEEPSIE URBAN AREA BOUNDARY IS DEFINED AS FOLLOWING THE SHORELINE
MAP LEGEND
Community Type
D deepwater
S shallows
F mud and sand flats
B sandy beach
R rocky shore
L lower marsh
U upper marsh
W tidal swamp forest
C freshwater creek
Exotic Plants
WC water chestnut
CR common reed
PL purple loosestrife
Major Features
AR abandoned ruins
BH bulkhead
BL boat launch ramp
BR bridge
DA dam or barrier




**HUDSON RIVER TIDAL HABITATS** **MAP NUMBER 8A**

N

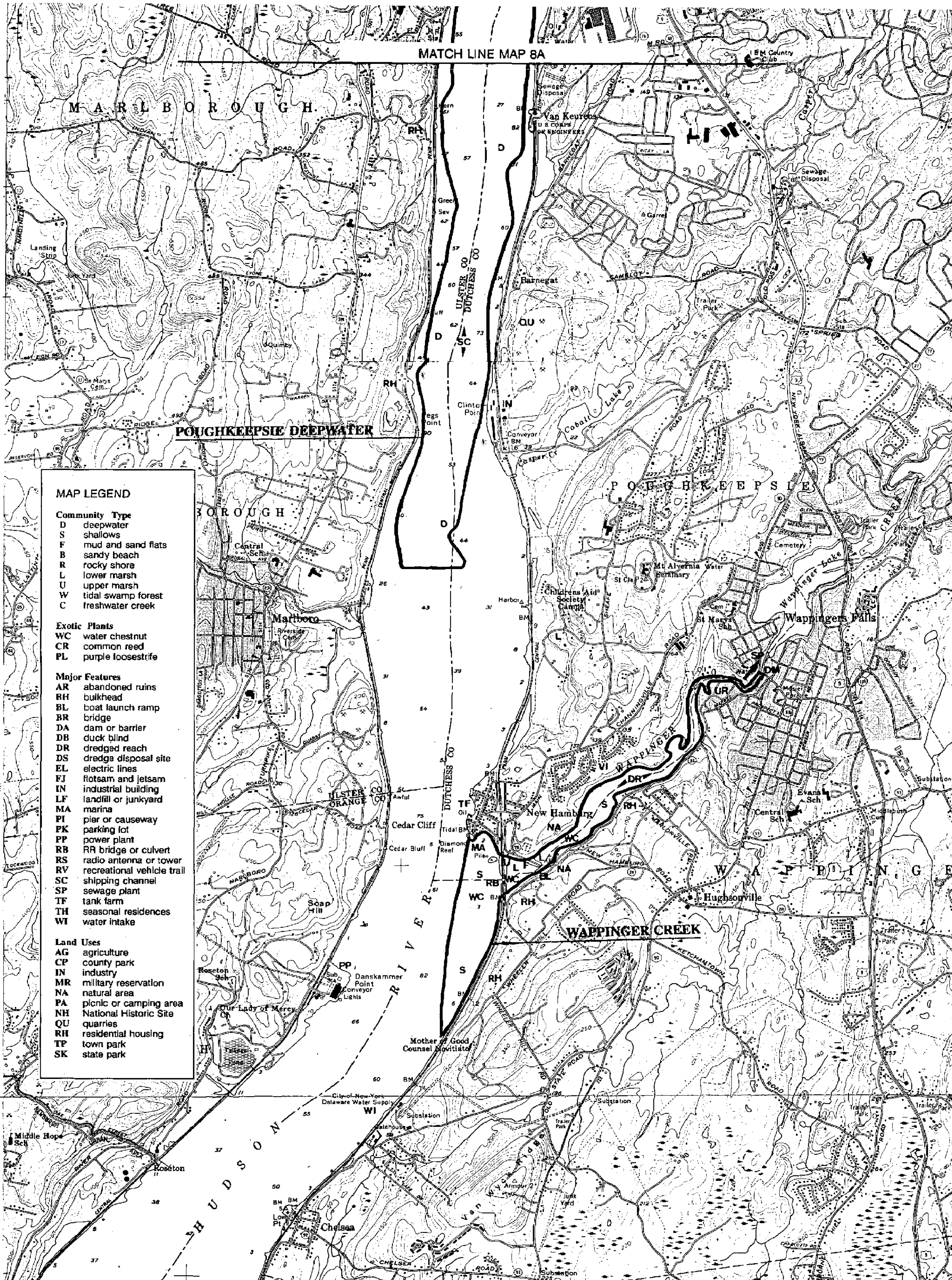
Miles

0 ½ 1

**Poughkeepsie Deepwater / Crum Elbow Marsh**

New York State Department of State Division of Coastal Resources and Waterfront Revitalization

Prepared by T. Hart and N. Salafsky December 1989




**HUDSON RIVER TIDAL HABITATS** **MAP NUMBER 8B**

**Poughkeepsie Deepwater / Wappinger Creek**

Miles 0 ½ 1

N

New York State Department of State Division of Coastal Resources and Waterfront Revitalization

Prepared by T. Hart and N. Salafsky December 1989

## GEOGRAPHIC INFORMATION

**Site Name:** Fishkill Creek

REFER TO MAP NUMBER 9A

**Town(s):** Fishkill, Beacon
**County(ies):** Dutchess
**7.5' Quad(s):** West Point

## BIOLOGICAL FEATURES

**Community Types:** Mostly shallows (S) and wooded upland with smaller amounts of mudflats (F), lower marsh (L), and upper marsh (U).

**Rare Species:** Important feeding site for migrating osprey and a potential osprey nesting site. Least bittern breeding. Estuary beggar-ticks, subulate arrowhead, kidney leaf mud-plantain.

**Valuable Species:** Important spawning area for anadromous fishes including alewife, blueback herring, white perch, striped bass, and tomcod. Extensive resident fish community including largemouth bass, bluegill, and brown bullhead. Also blue claw crabs, herons, and turtles.

**Size:** Medium sized marsh, mudflat, and shallows areas.

**Quality:** A *low* diversity habitat of *fair* quality that has experienced *moderate* disturbance.

**Exotics:** Extensive invasion by water chestnut (WC), limited to moderate invasions of common reed (CR) and purple loosestrife (PL).

**General Description:** The creek is a tidally-influenced, perennially warmwater stream with shallows, mudflats, and marsh components. At the creek mouth, east of the RR track, is an area with upper and lower marsh and west of the RR is a large shallow water area dominated by water chestnut. The site also includes Denning Point, an upland osprey roosting area.

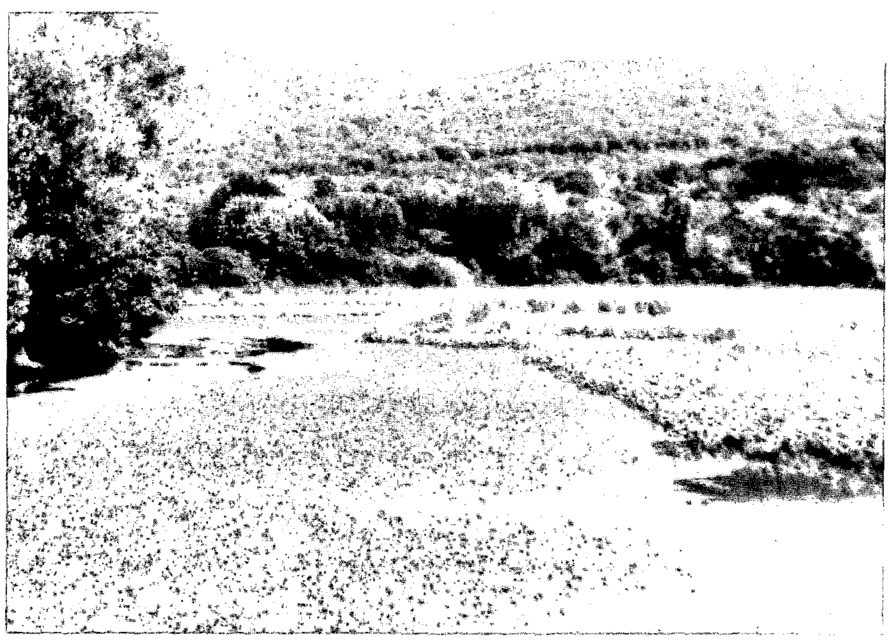


*Figure 57: Fishkill Creek channel with water chestnut and adjacent low and high marsh.*

## HUMAN INTERACTIONS

**Major Features:** Railroad embankment with bridges (RB), old ruins (AR), sewage plants (SP), industry (IN).

**Site History:** Hydrological and sedimentation patterns in the site were greatly altered when the railroad was built in the 1850's. Water flow is controlled at a dam located one-half mile upstream.

**Current Use:** Very limited fishing, upstream water withdrawals, scientific studies of the osprey. In the 1980's, an experimental osprey nest platform was erected on Denning Point. SPDES waste discharge permits were held in the early 1980's by Package Pavement Co., IBM Corp., Merritt Brooklands Inc., Texaco Research Center., Three Star Anodizing of Beacon., Tuck Industries., Inc.

**Surrounding Use:** Industry (IN), residential housing (RH), natural areas (NA).

**Status:** Designated as a Significant Coastal Fish and Wildlife Habitat. The area wholly or partially includes State-regulated freshwater wetlands (WT-1). Refer to the official wetland maps available in the Department of Environmental Conservation regional office. The site includes the NY Natural Heritage Program's Fishkill Creek Mouth site.

## HABITAT PROTECTION MEASURES

**Site Boundary:** Includes the entire designated Significant Coastal Fish and Wildlife Habitat area. The buffer zone should include the wooded areas bordering the site up to the Penn Central line to the north and the slopes above the RR to the south.

**Recommended Actions:** Investigate potential benefits of increasing water circulation in the marsh behind the RR track. Monitor and control upstream inflows to limit pollutants. Maintain Denning Point in its natural condition as much as possible.

**Incompatible Use:** Dredging or development within the tidal habitat. Disruptive activity during the osprey migration periods and during the summer breeding season if birds are successfully established at Denning Point. Intensive development of Denning Point.

**Recommended Use:** Increased small-scale recreational fishing. River access from the northern section of Denning Point.

**Knowledgeable Contacts:** Tom Hart, DOS; Dennis Mildner (Hudson River National Estuarine Sanctuary), DEC Region 3, Fisheries or Wildlife Manager or Environmental Protection Biologist.

GEOGRAPHIC INFORMATION

**Site Name:** Moodna Creek
**Town(s):** Cornwall, New Windsor
**County(ies):** Orange
**7.5' Quad(s):** Cornwall

REFER TO MAP NUMBER 9A

BIOLOGICAL FEATURES

**Community Types:** Predominantly freshwater creek (C) with shallows (S), mudflats (F), lower marsh (L), and upper marsh (U) associated with the creek mouth.

**Rare Species:** Major feeding and resting ground for migrating bald eagles and osprey. Limited summer feeding ground for bald eagles. Least bittern breeding area.

**Valuable Species:** Important spawning area for anadromous fishes including alewife, blueback herring, smelt, white perch, striped bass, and tomcod. Resident fish include largemouth bass, bluegill, pumpkin seed, brown bullhead, and various estuarine fish. Also many herons, snapping turtles, raccoons and muskrats.

**Size:** Medium to large marsh area, large mudflats, 3.5 miles of the creek of which the lower mile is tidally influenced.

**Quality:** A *moderate* diversity habitat of *good* quality that has experienced *moderate* disturbance.

**Exotics:** Limited invasion by water chestnut and purple loosestrife (PL).

**General Description:** The 2.5 mile long, non-tidal, upper part of Moodna Creek is a medium-gradient, perennially warmwater stream with a rocky substrate. The mile long tidal portion is deeper with a silt and clay substrate. A marsh exists at the mouth of the creek, west of the RR, and a large mudflat is located east of the RR.

*Figure 58: Shallows, low, and high marsh at Moodna Creek. Photo by Bryan Swift/DEC*

## HUMAN INTERACTIONS

**Major Features:** Sewage plants (SP), the RR with one bridge (RB), recreational vehicle use (RV), dam (DA), tank farm (TF).

**Site History:** Hydrological and sedimentation patterns in the site were greatly altered when the railroad was built in the 1850's. Water flow is controlled at a dam located 3.5 miles upstream.

**Existing Use:** Limited fishing, upstream water intake, RV use on mudflats. SPDES waste discharge permits were held in the early 1980's by Yellow Freight Systems, Star Expansion Company, Cornwall Paper Mills Inc., and various local sewage districts.

**Surrounding Use:** Residential housing (RH), industry (IN), natural areas (NA), quarries (QU).

**Status:** Designated as a Significant Coastal Fish and Wildlife Habitat. The area wholly or partially includes State-regulated freshwater wetlands (CO-10). Refer to the official wetland maps available at the Department of Environmental Conservation regional office. Sloop Hill is State-owned and under the jurisdiction of the Department of Environmental Conservation. Sloop Hill is also listed as a State unique area, which is a preliminary listing for eligibility as a State Natural Area and Historic Preserve. Much of the surrounding land is privately owned. The site includes the NY Natural Heritage Program's Moodna Creek Mouth site.

## HABITAT PROTECTION MEASURES

**Site Boundary:** Includes the entire designated Significant Coastal Fish and Wildlife Habitat area. The buffer zone should include the wooded banks bordering the Creek, the large natural area to the south of the Creek, and Sloop Hill.

**Recommended Actions:** Eliminate RV use of the mudflats. Monitor and limit herbicides entering the habitat from the RR. Avoid disturbance in the creek mouth area in the spring and summer when osprey and eagles are present.

**Incompatible Use:** Restriction of water flows. Physical and chemical barriers to fish migration during periods in early spring and summer and in December and January for tomcod. Marinas or other development resulting in boating traffic through shallows or flats. Clearing vegetation, introducing sediments, or removing large roosting trees for eagles and osprey.

**Recommended Use:** Provide direct access to the creek for increased fishing, bird watching.

**Knowledgeable Contacts:** Tom Hart, DOS; DEC Region 3, Fisheries or Wildlife Manager or Environmental Protection Biologist.

GEOGRAPHIC INFORMATION

**Site Name:** Hudson River Miles 44-56 REFER TO MAP NUMBER 9A & 9B
**Town(s):** Cornwall, Highlands, Stony Point, Philipstown, Cortlandt
**County(ies):** Orange, Rockland, Putnam, Westchester
**7.5' Quad(s):** West Point, Peekskill

BIOLOGICAL FEATURES

**Community Types:** Deepwater (D), shallows (S) and forested uplands.

**Rare Species:** Bald eagle winter feeding grounds. Possible nursery area for shortnose sturgeon.

**Valuable Species:** The major spawning area along the Hudson for striped bass and white perch (an estimated 50% of Northeast Atlantic striped bass stocks come from the Hudson). Narrow migration corridor for all anadromous fish spawning upriver including Atlantic sturgeon, blueback herring, American shad, alewife and rainbow smelt. Marine species such as bluefish, bay anchovy, silversides, hogchocker and blue claw crab reside in this area during periods of low freshwater flow (generally July through February)

**Size:** Twelve miles of deepwater along the River.

**Quality:** A *uniform* habitat of *excellent* quality that has experienced *limited* disturbance.

**Exotics:** None noted.

**General Description:** The site contains a narrow portion of the River between mean low water and the River bottom (up to 200 feet deep in places) with strong currents and a rocky bottom. The area is characterized by higher water flows than occur upriver (based on local tributary freshwater inflow) and seasonal changes in salinity. The area is generally the southern limit of freshwater spawning in the River. Three wetland areas (Con Hook, Manitou and Roa Hook Marshes) are adjacent to this deepwater site.

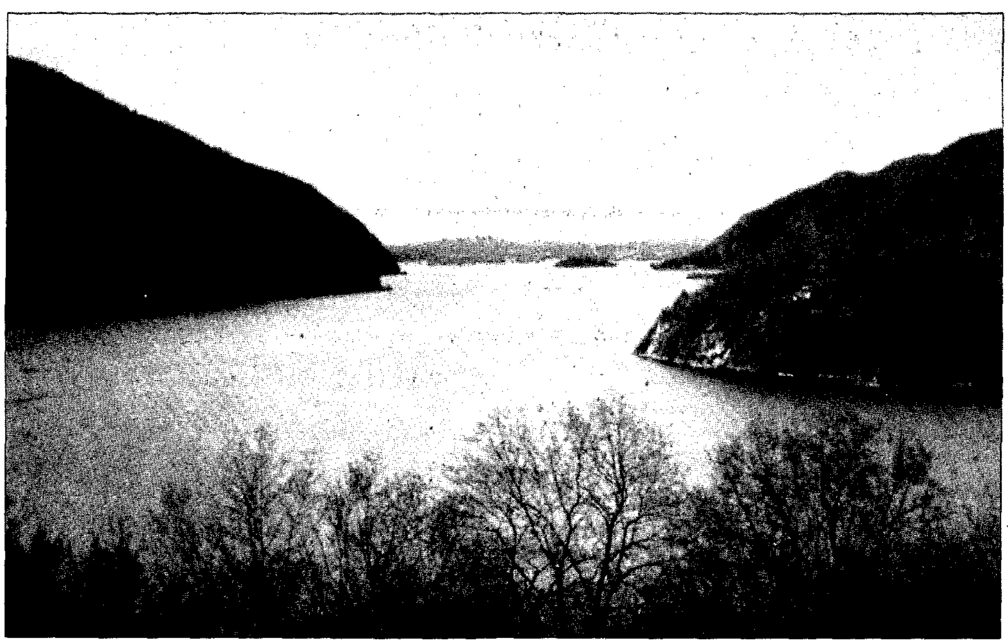


*Figure 59: View to north from West Point. Photo by Steve Stanne/Clearwater*

**HUMAN INTERACTIONS**

**Major Features:** Railroads on both sides of the River (RR), Bear Mountain Bridge (BR), Foundry Cove superfund site (see Constitution Island), sewage plants (SP), marinas (MA), shipping channel (SC).

**Site History:** The area is largely unaltered.

**Existing Use:** Extensive recreational fishing.

**Surrounding Land Use:** Villages, residential housing (RH), industry (IN), parking lot (PK), natural areas (NA), West Point and Camp Smith military reservations (MR), state parks (SK), quarries (QU).

**Status:** Designated as a Significant Coastal Fish and Wildlife Habitat. The site includes the NY Natural Heritage Program's Hudson River Mile 44-56 site. The adjacent wetland areas are not included in this site sue to substantially different resource values that are associated with these wetlands.

**HABITAT PROTECTION MEASURES**

**Site Boundary:** Includes the entire Significant Coastal Fish and Wildlife Habitat area. The buffer zone for this large area includes adjacent upriver and downriver sections of the River, the upriver major tributary streams, adjacent shores and marshes, and upland slopes along both sides of the River.

**Recommended Actions:** Minimize disturbance and noise in winter when the bald eagles are present. Undertake research on the dynamics of salt front movement. Protect the seasonal aspect of salinity changes by limiting water withdrawals, particularly during low flow conditions. Maintain existing natural areas adjacent to the River. Institute advanced stormwater runoff and non-point pollution sources in developed areas such as West Point. Control turbidity and sedimentation associated with restoration of Foundry Cove EPA superfund site to limit the introduction of heavy metal pollutants.

**Incompatible Use:** Any activities that would disrupt striped bass spawning including dredging and other construction activities during the period from May to July. Installation of water intakes that would cause impingement and/or entrainment of fish. Activities that would disrupt use of the area by eagles. Intensive development of Iona Island. Alteration of salinity concentrations or seasonal patterns.

**Recommended Use:** Increased fishing. Boating would tend to have less of an impact in this area than in other areas of the River.

**Knowledgeable Contacts:** Tom Hart, DOS; Betsy Blair and Dennis Mildner (National Estuarine Research Reserve). Jack Focht (Bear Mountain State Park). DEC Region 3, Fisheries or Wildlife Manager or Environmental Protection Biologist.

GEOGRAPHIC INFORMATION

**Site Name:** Constitution Marsh
**Town(s):** Philipstown
**County(ies):** Putnam
**7.5' Quad(s):** West Point

REFER TO MAP NUMBER 9B

BIOLOGICAL FEATURES

**Community Types:** Approximately equal amounts of shallows (S), mudflats (F), lower marsh (L), and upper marsh (U).

**Rare Species:** Least bittern nesting site. Osprey use during migrations.

**Valuable Species:** Very important nesting habitat for a variety of bird species including green-backed heron, various waterfowl, and passerine birds. Important feeding grounds for herons, and other wetland and shore birds. Significant spawning and feeding grounds for anadromous and resident fishes including alewife, blueback herring, white perch, striped bass, and largemouth bass. Muskrat population.

**Size:** Large tracts of all community types.

**Quality:** A *moderately* diverse habitat of *good* quality that has experienced *extensive* disturbance.

**Exotics:** Limited invasion by purple loosestrife (PL) and water chestnut (WC).

**General Description:** East of Constitution Island, the site contains a large marsh area cut by a grid of water channels. South of the island near the mouth of Indian Brook is a small area of marsh and a large shallows and mudflats area. North of the island are shallows, deepwater and limited segments of marsh that comprise Foundry Cove.

*Figure 60: View to south over Constitution Marsh. Photo by Bryan Swift/DEC*

## HUMAN INTERACTIONS

**Major Features:** The RR embankment with 2 bridges (RB), EPA Superfund site, bulkheads (BH), parking lot (PK).

**Site History:** Hydrological and sedimentation patterns in the site were greatly altered when the railroad was built in the 1850's. The area was also diked in the 1800's to grow rice. In the 1900's, a battery factory released large amounts of heavy metals including nickel, cobalt and cadmium into Foundry Cove leading to its designation as an EPA superfund site. Current plans call for dredging the contaminated sediments from the site and replanting the marsh.

**Existing Use:** Wildlife Sanctuary managed by the National Audubon Society. Fishing and crabbing in Foundry Cove and other parts of the site despite severe contamination and substantial health risks.

**Surrounding Use:** Residential housing (RH), the Village of Cold Spring, industry (IN), natural areas (NA).

**Status:** Designated as a Significant Coastal Fish and Wildlife Habitat. Most of the site is owned by NYS and managed by the National Audubon Society as a wildlife sanctuary; the remaining area is privately owned. The area wholly or partially includes State-regulated freshwater wetlands (WP-7). Refer to the official wetland maps available in the Department of Environmental Conservation regional office. The site includes the Natural Heritage Program's Constitution Marsh site.

## HABITAT PROTECTION MEASURES

**Site Boundary:** Includes the entire designated Significant Coastal Fish and Wildlife Habitat area. The buffer zone should include the upland woods to the east as far as Route 9D, and watersheds of the three tributary streams: Foundry Brook, Indian Brook and Philipse Brook.

**Recommended Actions:** Clean up heavy metal contamination. Conduct dredging in a manner that will avoid secondary contamination of other areas by suspended sediment. Minimize interference with animal populations by concentrating cleanup efforts in fall and winter as much as possible. The isolation that is afforded by the RR embankment with its limited connection to the River provides an opportunity to limit transport of heavy metals out of the cove. Evaluate the use of clean dredge material from the shipping channel as cover and replacement marsh substrate. Carefully plan and monitor replacement marsh; site restoration provides an excellent opportunity to test marsh creation practices along the Hudson. Place warning signs immediately to deter fishing. Allow artificial drainage channels in the marsh to revert to natural marsh to increase flooding of wetland vegetation.

**Incompatible Use:** Fishing and other consumptive uses in the area. Dredging or filling of non-contaminated portions of the site. Clearing vegetation and introducing sources of sedimentation.

**Recommended Use:** Increased nature observation, test site for marsh reconstruction.

**Knowledgeable Contacts:** Tom Hart, DOS; Jim Rod, National Audubon Society. DEC Region 3, Fisheries or Wildlife Manager or Environmental Protection Biologist.

GEOGRAPHIC INFORMATION

**Site Name:** Iona Island Marsh
**Town(s):** Stony Point
**County(ies):** Rockland
**7.5' Quad(s):** Peekskill

REFER TO MAP NUMBER 9B

BIOLOGICAL FEATURES

**Community Types:** Predominantly upper marsh (U), followed by shallows (S) and flats (F), with lesser amounts of woody tidal swamp (W) and non-tidal freshwater marsh.

**Rare Species:** Least bittern nesting, adjacent bald eagle winter roosting. Walking fern and prickly pear cactus.

**Valuable Species:** Extensive breeding for many bird species. Muskrat and possibly other furbearers, amphibians (mostly limited to non-tidal freshwater marsh areas), snapping turtle, and blue claw crab. Heron and shorebird feeding. Spawning and/or nursery for anadromous and resident fishes including alewife, blueback herring, white perch, and striped bass.

**Size:** Following Constitution and Piermont Marshes, the largest expanse of wetland along the lower part of the estuary. Limited patches of freshwater marsh and woody swamp forest.

**Quality:** A *highly* diverse habitat of *excellent* quality that has experienced *moderate* disturbance.

**Exotics:** Limited invasion by common reed (CR) and purple loosestrife (PL).

**General Description:** Large open expanses of barely brackish marshes (0-6 ppt salinity) behind Iona Island, bisected by a causeway. North of the road are marsh, mudflat, and shallow littoral areas along Doodletown Brook, while south of the road are the same communities plus limited areas of shrubby swamp near a small tributary stream. Patches of freshwater marsh are associated with tributaries such as the area immediately behind Iona Island. The tidal creeks roughly define two sections of marsh: Salisbury Meadow to the west, and Ring Meadow to the east.

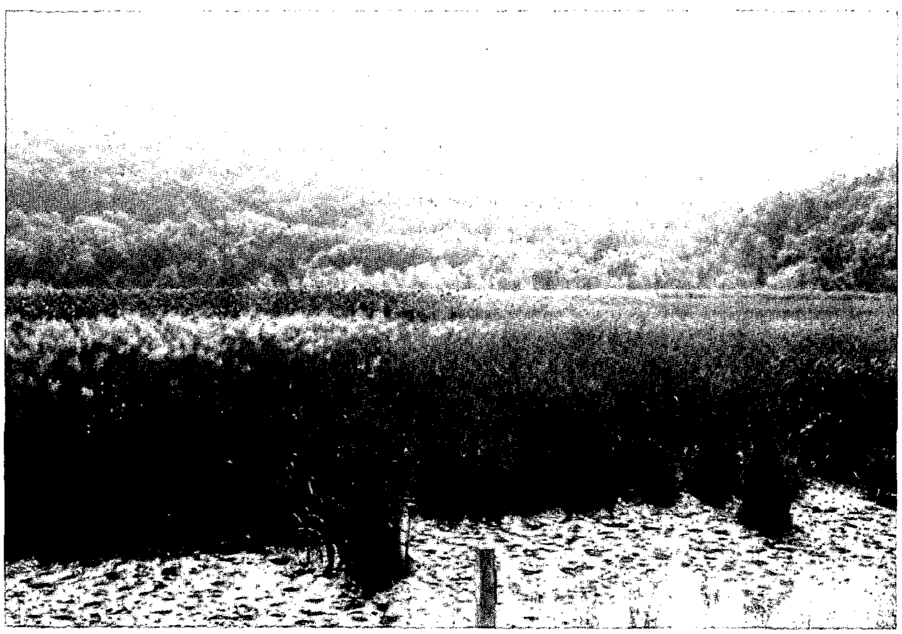


*Figure 61: High marsh and flats behind Iona Island viewed to the southwest.*

## HUMAN INTERACTIONS

**Major Features:** The railroad with two bridges (RB), an elevated causeway to Iona Island (PI), sewage plant (SP), shipping channel (SC).

**Site History:** Hydrological and sedimentation patterns in the site were greatly altered when the railroad was built in the 1850's. During both World Wars I and II, Iona Island was used as a storage site and munitions works by the military. After WW II, naval ships were mothballed in the River near the site. Old causeways and dikes are located within the marshes.

**Existing Use:** Iona Island and its associated marshes are managed by the Palisades Interstate Park Commission as a natural area and bird sanctuary. Active interpretive programs and scientific research.

**Surrounding Use:** State parks (SK), natural areas (NA), military reservation (MR). Iona Island is used as a "pioneer camping" area for large-group experiences sponsored by the Palisades Interstate Park Commission.

**Status:** Designated as a Significant Coastal Fish and Wildlife Habitat. The site is administered by the Palisades Interstate Park Commission as part of Bear Mountain State Park. One of four sites comprising the Hudson River National Estuarine Research Reserve and registered as a National Natural Landmark by the National Park Service. The area wholly or partially includes State-regulated freshwater wetlands (PK-1). Refer to the official wetland maps available in the Department of Environmental Conservation regional office. The site includes the Natural Heritage Program's Iona Island site.

## HABITAT PROTECTION MEASURES

**Site Boundary:** Includes the entire designated Significant Coastal Fish and Wildlife Habitat area. The buffer zone should include the watersheds of Doodletown Brook, Snake Hole Creek, and Iona Island.

**Recommended Actions:** Ensure that herbicides from the RR and runoff from the highways do not enter the tidal environment. Establish watershed management programs on the tributary streams.

**Incompatible Use:** Any activity that would further restrict tidal flow. Dredging or construction within the habitat. Destabilization of adjacent bluffs. Intense use of Iona Island.

**Recommended Use:** Iona Island could be developed as a natural park if such use were compatible with the bald eagle winter use. Park development should center on the unique ecological resource associated with Iona Island including resources of the island, marshes and River. Excellent site for education concerning the tidal marshes with opportunities to expand research and education programs which would be facilitated by the unique access provided by the causeway.

**Knowledgeable Contacts:** Tom Hart, DOS; Betsy Blair and Dennis Mildner (Hudson River National Estuarine Sanctuary), DEC Region 3, Fisheries or Wildlife Manager or Environmental Protection Biologist. Jack Focht (Bear Mountain State Park).

## GEOGRAPHIC INFORMATION

**Site Name:** Camp Smith Marsh and Annsville Creek — REFER TO MAP NUMBER 9B
**Town(s):** Cortlandt, Peekskill
**County(ies):** Westchester
**7.5' Quad(s):** Peekskill

## BIOLOGICAL FEATURES

**Community Types:** Largely shallows (S) and creek (C) with smaller amounts of mudflats (F) and upper marsh (U).

**Rare Species:** Spongy arrowhead.

**Valuable Species:** Not known.

**Size:** Small marsh, medium to large shallows.

**Quality:** A *low* diversity habitat of *fair* quality that has experienced *moderate* disturbance.

**Exotics:** Moderate to heavy invasion by common reed (CR).

**General Description:** A small marsh area near a small tributary stream at Camp Smith, and a large shallows and creek area associated with Annsville Creek.

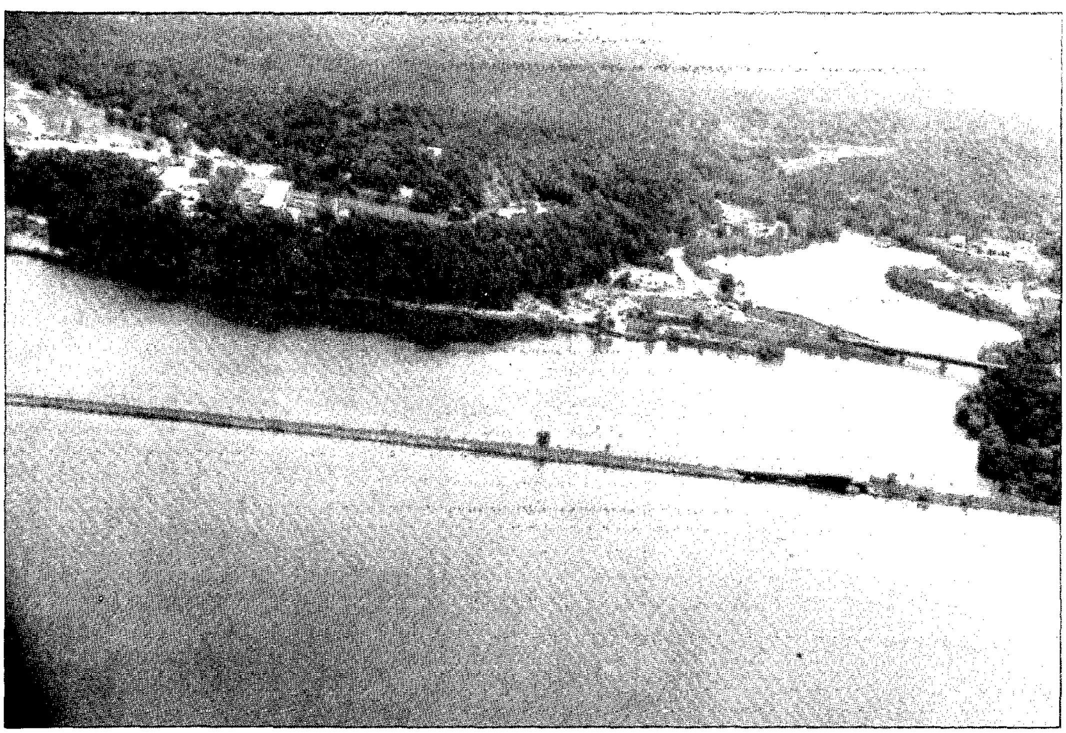


*Figure 62: Aerial view of Camp Smith and Annsville Creek to the northeast. Photo by Harry Dodson/Dodson Associates*

## HUMAN INTERACTIONS

**Major Features:** Extensive road system, RR with one tidal outlet (RB), tank farm (TF), Camp Smith military reservation (MR), residential housing (RH), dredged area (DR), sewage plants (SP), power plants (PP).

**Site History:** Hydrological and sedimentation patterns in the site were greatly altered when the railroad was built in the 1850's. Peekskill Harbor was dredged in 1922, 1928, 1937, and 1938.

**Existing Use:** A SPDES waste discharge permit was held in the early 1980's by the Peekskill Sewage District.

**Surrounding Use:** Highways, military reservation (MR), industry (IN), Indian Point Power Plant (PP), urban areas , residential housing (RH).

**Status:** Recognized by the NY Natural Heritage Program as containing rare communities. The area wholly or partially includes State-regulated freshwater wetlands (P-4). Refer to the official wetland maps available at the Department of Environmental Conservation Regional Office.

## HABITAT PROTECTION MEASURES

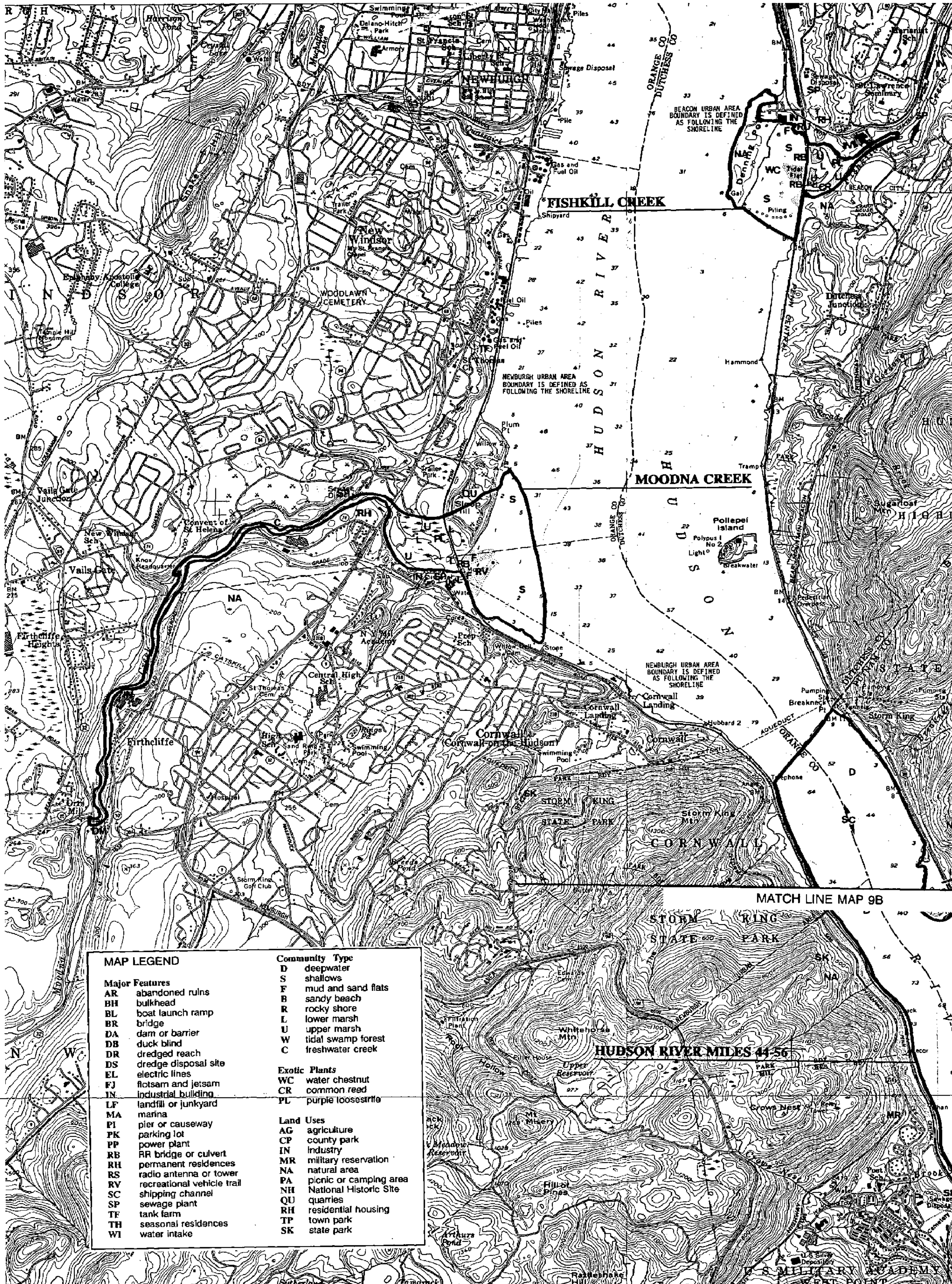
**Site Boundary:** Site boundaries are taken from the NYS Heritage Program. Buffer areas include the immediate upland and watercourses for Sprout Brook, Peekskill Creek, and Annsville Creek.

**Recommended Actions:** Monitor and protect against leakage or spills from the tank farm. Control runoff from the highways and limit railroad herbicides entering the water. Additional evaluation of this area is needed to document potential resource values.

**Incompatible Use:** Dredging, fill and construction in the habitat. Any activity that might restrict water flow. Clearing buffer vegetation and uncontrolled grading.

**Recommended Use:** None identified.

**Knowledgeable Contacts:** Tom Hart, DOS; DEC Region 3, Fisheries or Wildlife Manager or Environmental Protection Biologist. Carol Reschke and Caryl DeVries, The Nature Conservancy.




**HUDSON RIVER TIDAL HABITATS** **MAP NUMBER 9A**

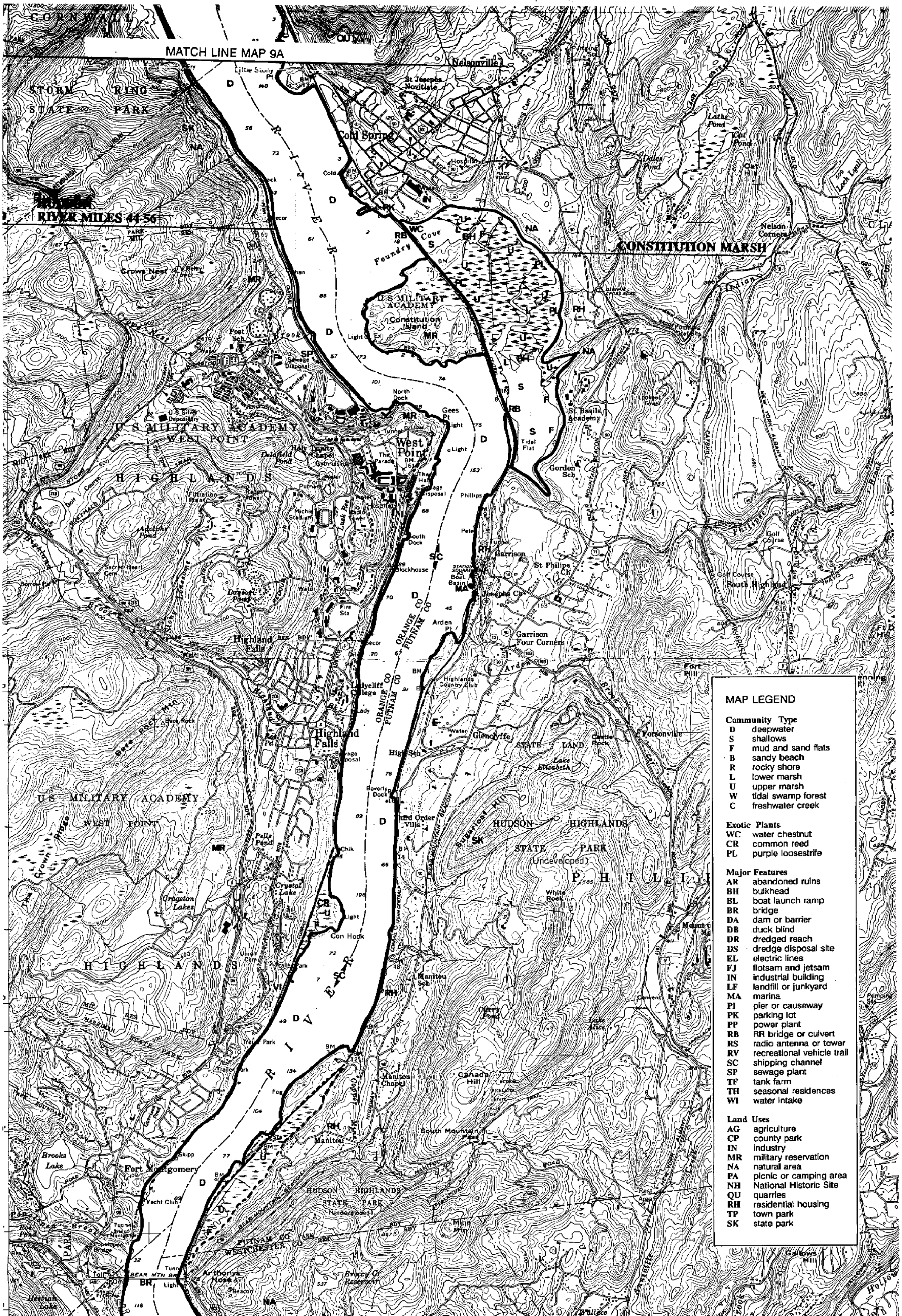
**Fishkill Creek / Moodna Creek / Hudson River Miles 44-56**

Miles 0 ½ 1

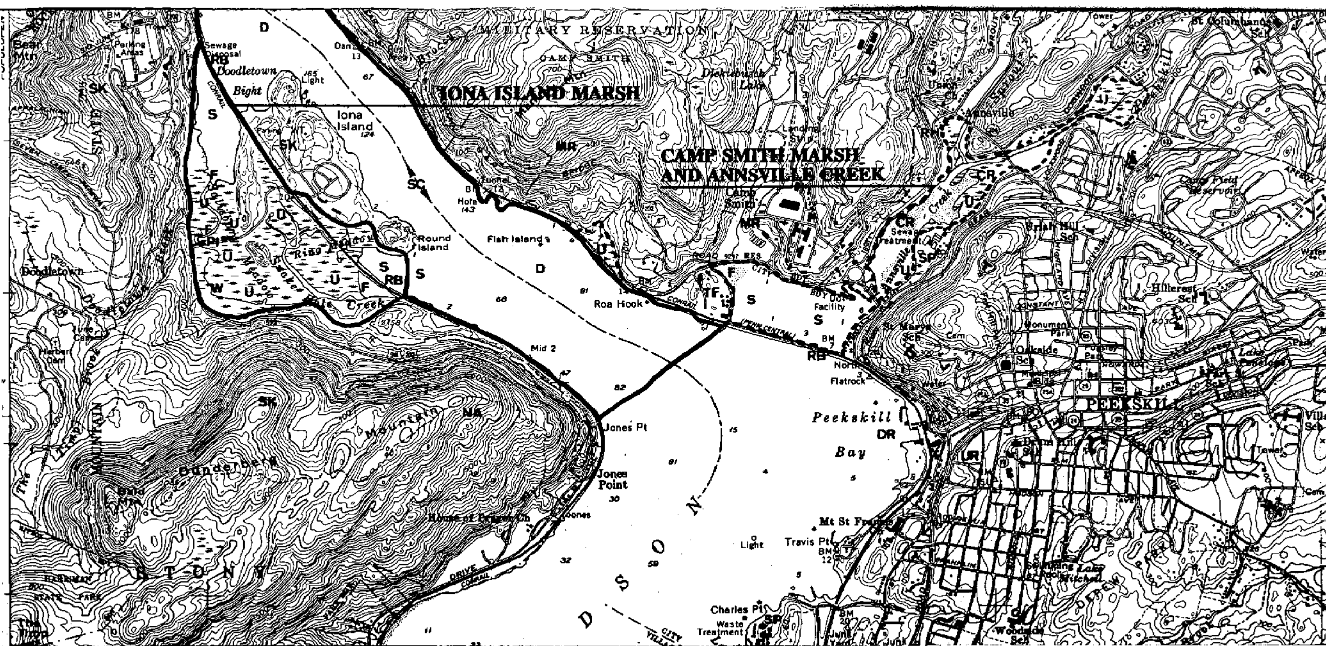
N

New York State Department of State Division of Coastal Resources and Waterfront Revitalization

Prepared by T. Hart and N. Salafsky December 1989



MATCH LINE MAP 9A
HUDSON RIVER MILES 44-56
CONSTITUTION MARSH
CORNWALL
STORM KING STATE PARK
Nelsonville
Cold Spring
Foundry Cove
U S MILITARY ACADEMY
Constitution Island
West Point
U S MILITARY ACADEMY WEST POINT
HIGHLANDS
Garrison
Highland Falls
Ladycliff College
HUDSON HIGHLANDS STATE PARK (Undeveloped)
Manitou
Fort Montgomery
Anthonys Nose
PUTNAM CO
WESTCHESTER CO
ORANGE CO
MAP LEGEND
Community Type
D deepwater
S shallows
F mud and sand flats
B sandy beach
R rocky shore
L lower marsh
U upper marsh
W tidal swamp forest
C freshwater creek
Exotic Plants
WC water chestnut
CR common reed
PL purple loosestrife
Major Features
AR abandoned ruins
BH bulkhead
BL boat launch ramp
BR bridge
DA dam or barrier
DB duck blind
DR dredged reach
DS dredge disposal site
EL electric lines
FJ flotsam and jetsam
IN industrial building
LF landfill or junkyard
MA marina
PI pier or causeway
PK parking lot
PP power plant
RB RR bridge or culvert
RS radio antenna or tower
RV recreational vehicle trail
SC shipping channel
SP sewage plant
TF tank farm
TH seasonal residences
WI water intake
Land Uses
AG agriculture
CP county park
IN industry
MR military reservation
NA natural area
PA picnic or camping area
NH National Historic Site
QU quarries
RH residential housing
TP town park
SK state park




## HUDSON RIVER TIDAL HABITATS     MAP NUMBER 9B

**Hudson River Miles 44-56 / Constitution Marsh / Iona Island Marsh / Camp Smith Marsh and Annsville Creek**

Miles
0 ½ 1

N

New York State Department of State Division of Coastal Resources and Waterfront Revitalization

Prepared by T. Hart and N. Salafsky December 1989

## GEOGRAPHIC INFORMATION

REFER TO MAP NUMBER 10

**Site Name:** Haverstraw Bay
**Town(s):** Clarkstown, Haverstraw, Stony Point, Cortlandt
**County(ies):** Rockland, Westchester
**7.5' Quad(s):** Haverstraw

## BIOLOGICAL FEATURES

**Community Types:** Deepwater (D) and shallows (S).

**Rare Species:** Shortnose sturgeon wintering area.

**Valuable Species:** Extensive nursery for anadromous fish species including striped bass, American shad, white perch, tomcod, and Atlantic sturgeon. Nursery and feeding area for many marine species including bay anchovy, Atlantic menhaden, and blue claw crab. Spawning and wintering grounds for Atlantic sturgeon. Waterfowl feeding and resting during migration.

**Size:** Vast areas of deep and shallow water over a six mile reach of River.

**Quality:** A *low* diversity habitat of *good* quality that has experienced *extensive* disturbance.

**Exotics:** None identified.

**General Description:** A vast open area of the River containing extensive shallows and deeper water along the western side of the area. Over this relatively shallow bay, freshwater and saltwater mix to produce brackish waters varying from 0 to 10 ppt salinity. Nursery values in the habitat are probably greatest in spring, summer and fall but depend on the salinity found in the area.

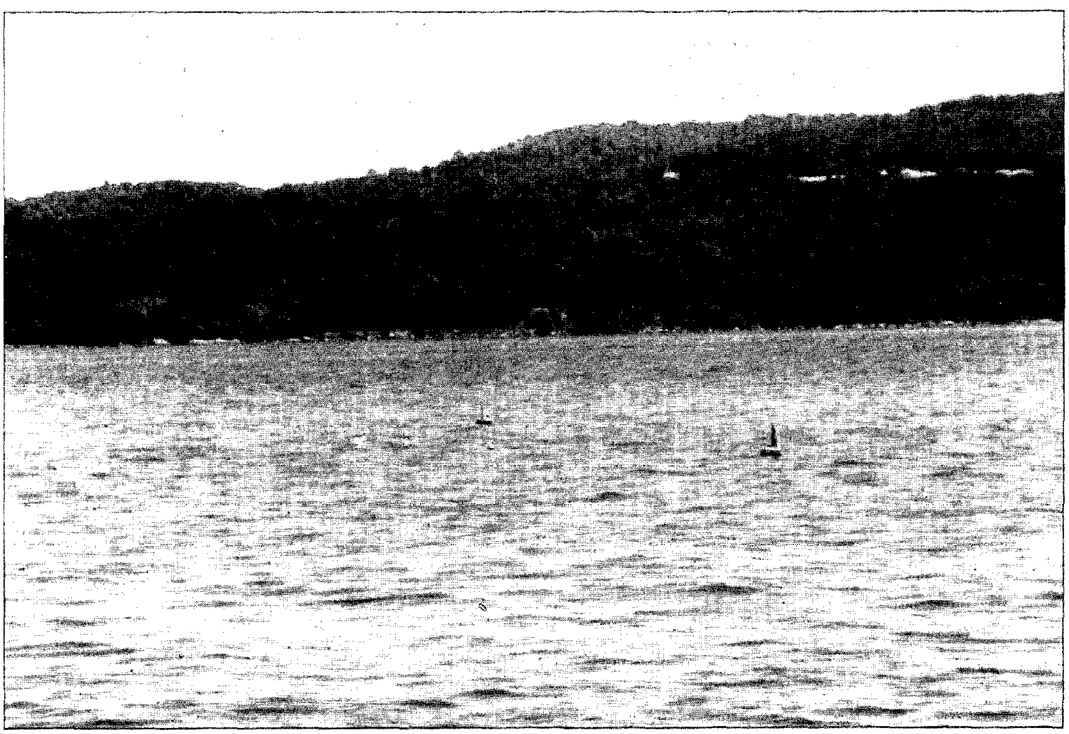


*Figure 63: Anchored gill nets in Haverstraw Bay. Photo by Steve Stanne/Clearwater*

## HUMAN INTERACTIONS

**Major Features:** Sewage plants (SP), power plants (PP), landfill (LF), marinas (MA), surrounding roads and railroads, shipping channel (SC), dredging reach B (DR).

**Site History:** The River channel was first dredged in the 1920's with subsequent maintenance dredging and disposal.

**Existing Use:** Moderate to heavy fishing. SPDES waste discharge permits were held in the early 1980's by Consolidated Edison's Indian Point Generating Station, Georgia Pacific Corp., Kay-Fries Chemicals, Inc., Orange and Rockland Utilities Bowline Pt. Generating Station, Tilcon Quarries, Inc., United States Gypsum Co., and local sewage districts.

**Surrounding Use:** Industry (IN), highways and railroad (RR), urban areas, villages, residential housing (RH), county parks (CP), state park (SK), natural areas (NA).

**Status:** Designated as a Significant Coastal Fish and Wildlife Habitat. The area wholly or partially includes State-regulated freshwater wetlands (HS-2, HS-11). Refer to the official wetland maps available at the Department of Environmental Conservation regional office.

## HABITAT PROTECTION MEASURES

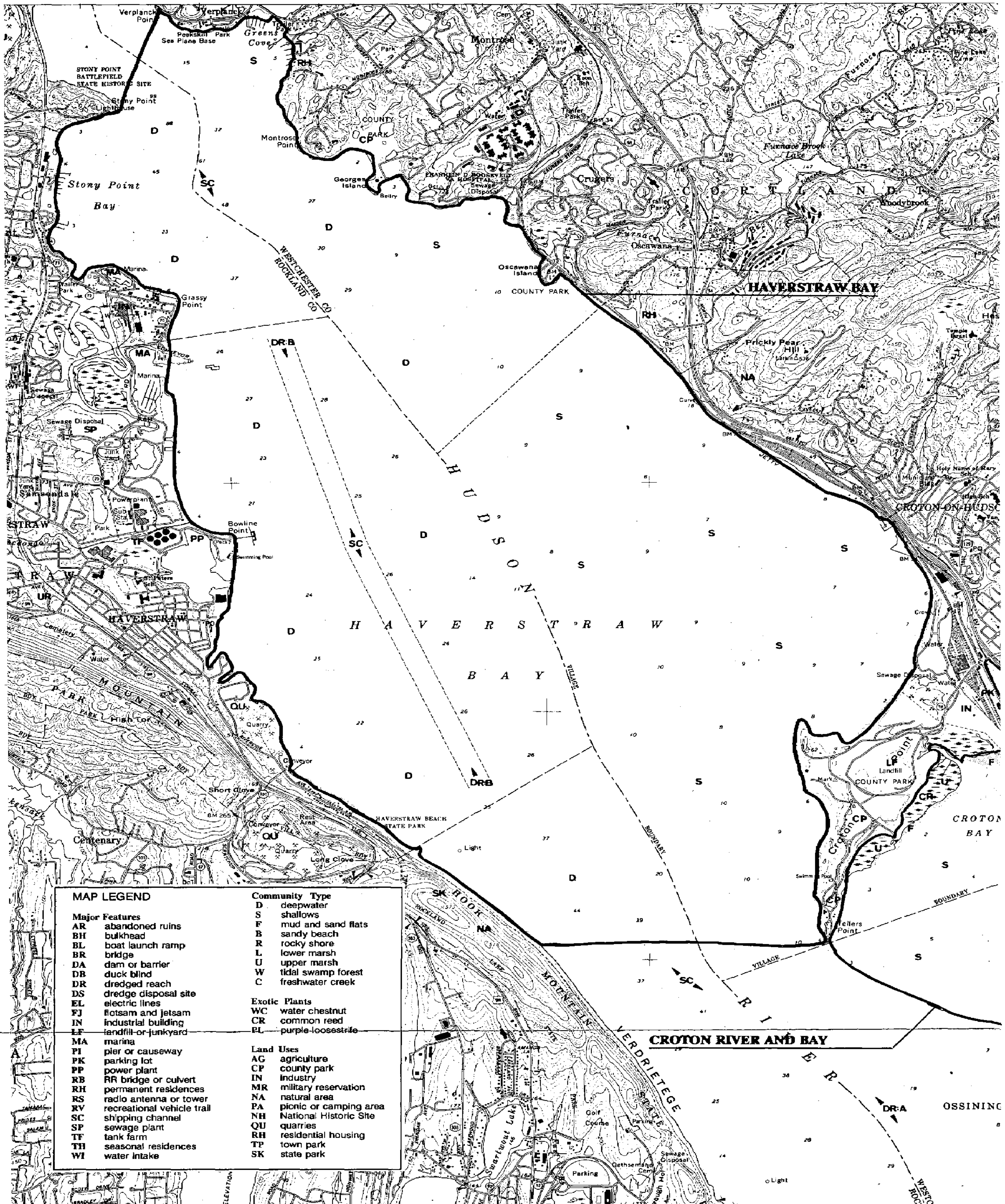
**Site Boundary:** Includes the entire designated Significant Coastal Fish and Wildlife Habitat area. The buffer area includes adjacent portions of the River itself and the immediate watershed along both sides of the River. Along the western shore this extends to the crest of the steep slopes and, on the eastern shore, includes upland slopes extending to approximately the 100 foot contour.

**Recommended Actions:** Monitor and limit existing runoff from the roads, railroad, and industrial and landfill areas along both shores. Limit non-resource related (recreational) boating over the shallows throughout the entire eastern portion of the bay. Pursue active restoration of industrial and otherwise de-vegetated sites immediately adjacent to the River: this would include establishing vegetated and permeable buffer areas to limit direct runoff and erosion.

**Incompatible Use:** Dredging of the shallows and construction or filling in the habitat. Large scale removal of freshwater that may alter the variation in salinity over this shallow area. If mixing of salt and freshwater occurred further upriver over deep water as a result of water withdrawals, many of the habitat values associated with the bay would be lost and not replaced elsewhere in the River. Navigation channel dredging during sensitive nursery use of the area. Marina development along the eastern shore which would result in boating traffic patterns entirely through shallows during the critical summer months. Boating along the western shore would tend to have less adverse effects. Introduction of sediments, clearing buffer vegetation.

**Recommended Use:** Increased fishing.

**Knowledgeable Contacts:** Tom Hart, DOS; DEC Region 3, Fisheries or Wildlife Manager or Environmental Protection Biologist.




## HUDSON RIVER TIDAL HABITATS MAP NUMBER 10

Miles

0 ½ 1

N

### Haverstraw Bay

New York State Department of State Division of Coastal Resources and Waterfront Revitalization

Prepared by T. Hart and N. Salafsky December 1989

GEOGRAPHIC INFORMATION

**Site Name:** Croton River and Bay
**Town(s):** Cortlandt, Ossining
**County(ies):** Westchester
**7.5' Quad(s):** Haverstraw, Ossining

REFER TO MAP NUMBER 11

BIOLOGICAL FEATURES

**Community Types:** Mostly shallows (S) with lesser amounts of mudflats (F) and brackish upper marsh (U).

**Rare Species:** Possible osprey feeding grounds during spring and fall migrations.

**Valuable Species:** Productive nursery, foraging and resting area for anadromous and resident fish species.

**Size:** Large areas of shallow water, limited marsh and mudflats areas.

**Quality:** A *low* diversity habitat of *poor* quality that has experienced *extensive* disturbance.

**Exotics:** Extensive invasion by common reed (CR).

**General Description:** A large open bay area sheltered by Croton Point. There are limited marsh areas along the point, a large area of shallow water, and the tidal portion of the Croton River. Most of the freshwater flow is diverted to municipal water supplies except for overflows and minimum flow requirements.

*Figure 64: Croton River from Quaker Bridge. Photo by Bryan Swift/DEC*

HUMAN INTERACTIONS

**Major Features:** County park (CP), the RR with one tidal flow opening (RB), large landfill (LF), sewage plant (SP), parking lot (PK), dam (DA), shipping channel (SC), dredging reach A (DR).

**Site History:** Hydrological and sedimentation patterns in the site were greatly altered when the railroad was built in the 1850's. The River channel was first dredged in the 1920's with subsequent maintenance dredging and deposition. Encroachment by the landfill into the upper marsh.

**Existing Use:** Entire flow from the Croton River used for municipal water supplies. Moderate to heavy fishing use. SPDES waste discharge permits were held in the early 1980's by Sunmark Industries, Consolidated Rail Corp., Mobil Oil Corp, and the Ossining Sewage District. Scientific research (Hudsonia, Inc.).

**Surrounding Use:** Industry (IN), highways and railroad (RR), urban areas.

**Status:** Designated as a Significant Coastal Fish and Wildlife Habitat. The area wholly or partially includes State-regulated freshwater wetlands (H-3, H-4, H-5). Refer to the official wetland maps available in the Department of Environmental Conservation regional office. The site includes the Natural Heritage Program's Croton River and Bay site.

HABITAT PROTECTION MEASURES

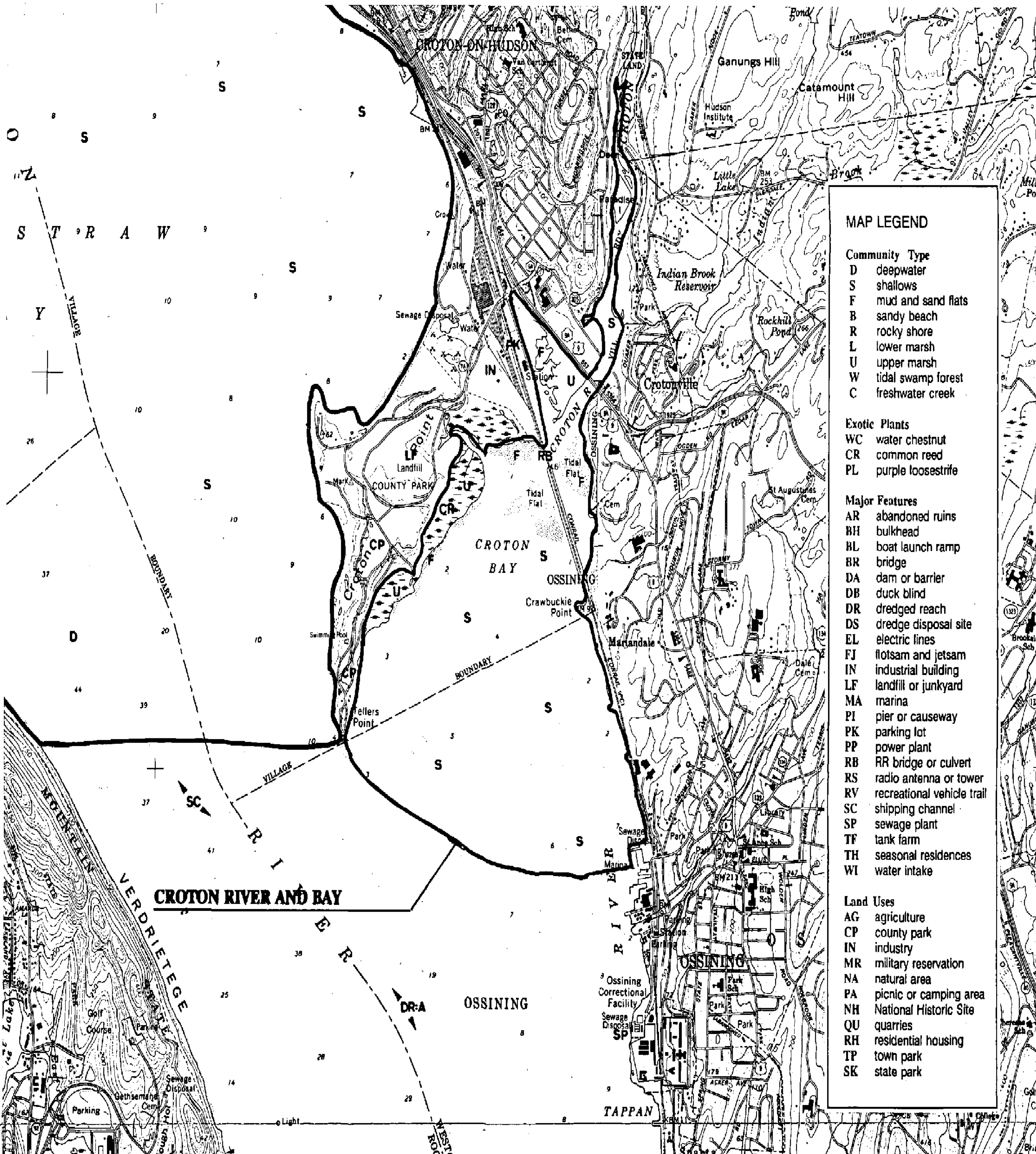
**Site Boundary:** Includes the entire designated Significant Coastal Fish and Wildlife Habitat area. The buffer area includes Croton Point to the north, upland to Route 9J and up to and including the roadways paralleling the Croton River corridor.

**Recommended Actions:** Restore continuous freshwater flow to the Croton River to improve the habitat value of the site (currently freshwater flow releases can be reduced to zero during draught conditions). Monitor and control runoff from the roads, railroad, industry, and landfill areas around the site through stormwater and non-point sources of pollution control programs.

**Incompatible Use:** Dredging, filling and construction in the habitat. Clearing adjacent vegetated uplands and banks. Marina development or other developments resulting in boating traffic largely through the shallows or flats. Further decreases in tidal flow within the Croton River. Introduction of waste materials in association with bridge maintenance (Route 9J and RR bridges).

**Recommended Use:** None identified.

**Knowledgeable Contacts:** Tom Hart, DOS; DEC Region 3, Fisheries or Wildlife Manager or Environmental Protection Biologist.




## HUDSON RIVER TIDAL HABITATS

## MAP NUMBER 11

Miles

0 ½ 1

N

### Croton River and Bay

New York State Department of State Division of Coastal Resources and Waterfront Revitalization

Prepared by T. Hart and N. Salafsky December 1989

GEOGRAPHIC INFORMATION

REFER TO MAP NUMBER 12

**Site Name:** Piermont Marsh
**Town(s):** Orangetown
**County(ies):** Rockland
**7.5' Quad(s):** Nyack

BIOLOGICAL FEATURES

**Community Types:** Predominantly shallows (S) and brackish upper marsh (U), with a broad transition area of mudflats (F).

**Rare Species:** Least bittern and sedge wren reported nesting, diamondback terrapin use, osprey feeding during migration.

**Valuable Species:** Extensive use of the mudflats by herons and egrets. Large numbers of resident and breeding bird species, blue claw crabs, resident fishes and lesser numbers of furbearers. Waterfowl, wading bird and shorebird feeding during migration.

**Size:** Large marsh and shallows areas. Largest brackish water marsh within River.

**Quality:** A *low* diversity habitat of *fair* quality that has experienced *moderate* disturbance.

**Exotics:** Extensive invasion by common reed (CR) throughout most of the marsh, particularly concentrated at the north end.

**General Description:** A large common reed dominated marsh area that extends south of the Piermont Pier. East of this marsh is a large shallows and mudflats area. Many of the plants found here illustrate the transition to a more saline environment and include saltmarsh cordgrass, saltmeadow cordgrass, and salt grass.

*Figure 65: Northeast view over Piermont Marsh.*

## HUMAN INTERACTIONS

**Major Features:** A long pier (PI), town park (TP), residential housing (RH), sewage outlet (SP).

**Site History:** The marsh formed behind the pier which was constructed in 1839 as the eastern terminus of the Erie Railroad. Prior to construction of the pier, the area was open water.

**Existing Use:** Bird watching and nature study as part of Tallman Mountain State Park. Active research and education programs.

**Surrounding Use:** Tallman Mountain State Park (SK), factories (IN), the Village of Piermont, natural areas (NA).

**Status:** Designated as a Significant Coastal Fish and Wildlife Habitat. The north end of the park is State-owned and administered by the NYS DEC, the remainder is under the jurisdiction of the Palisades Interstate Park Commission. The area is one of four designated sites comprising the Hudson River National Estuarine Research Reserve. The area includes State-regulated tidal wetlands. Refer to the official wetland maps available in the Department of Environmental Conservation regional office. The site includes the Natural Heritage Program's Piermont Marsh site.

## HABITAT PROTECTION MEASURES

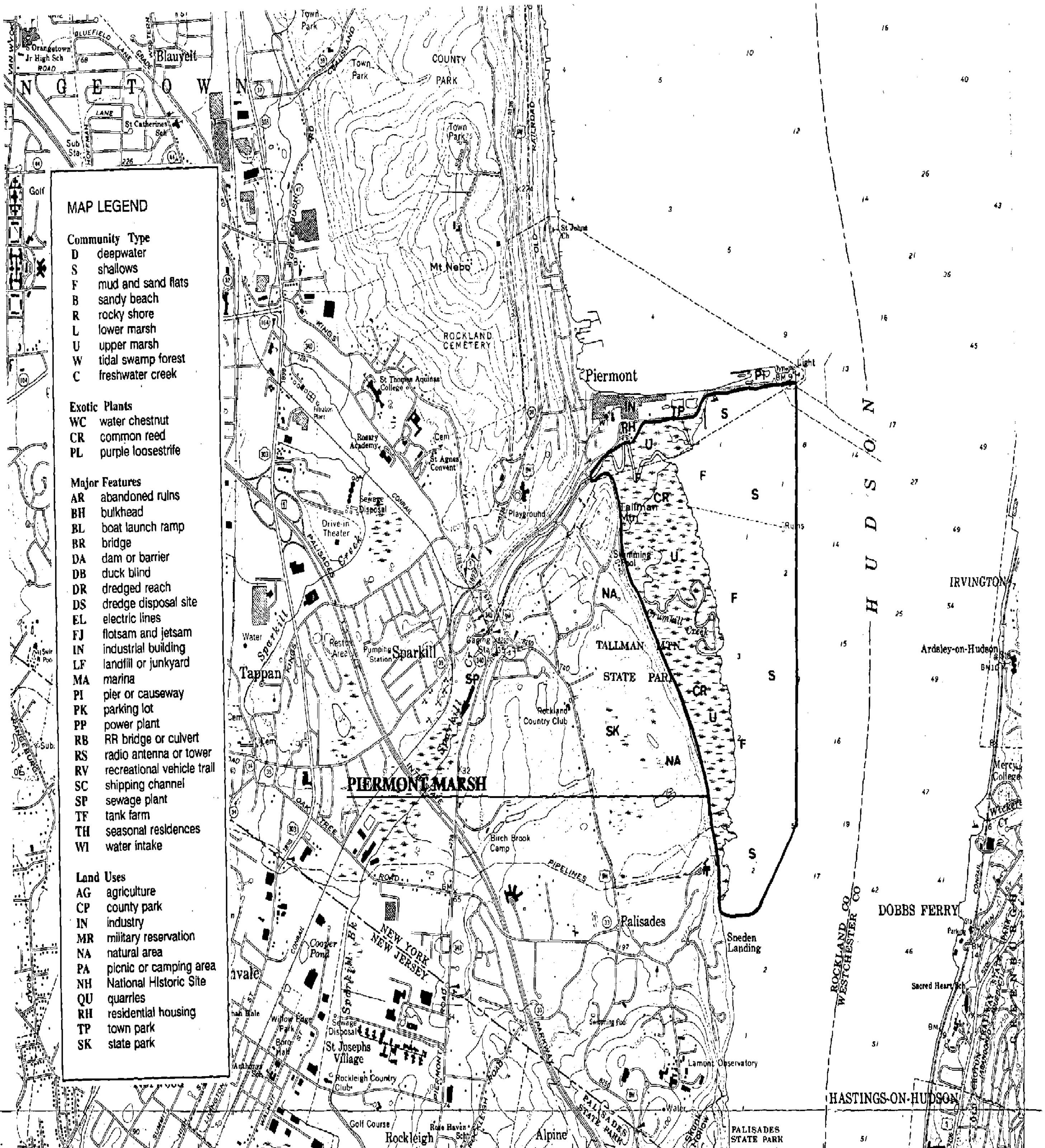
**Site Boundary:** Includes the entire Significant Coastal Fish and Wildlife Habitat boundary. The buffer zone should include the upland forests to the west within Tallman State Park, portions of the Sparkill Creek watershed and the Piermont Pier.

**Recommended Actions:** Evaluate selective restoration of the marsh through common reed control; high sedimentation rates, however, may require extensive dredging for restoration efforts to be successful and may result in creating negative impacts that would exceed potential benefits. Monitor recurring problem of sewage loading due to breaks in the sewage outfall pipe that passes through the marsh, flats, and shallows. Control sedimentation in the area through watershed management programs.

**Incompatible Use:** Any action that would subdivide the overall site. Adjacent development that would increase runoff. Alteration of tidal channels resulting in hydrological changes. Marina development that would result in boating traffic within the shallows and flats, or increase direct impacts from boat beaching in the marsh and flats.

**Recommended Use:** Bird watching center and expanded opportunities for research and education.

**Knowledgeable Contacts:** Tom Hart, DOS; Betsy Blair and Dennis Mildner (National Estuarine Research Reserve), DEC Region 3, Fisheries or Wildlife Manager or Environmental Protection Biologist.




## HUDSON RIVER TIDAL HABITATS MAP NUMBER 12

N

Miles

0 ½ 1

### Piermont Marsh

New York State Department of State Division of Coastal Resources and Waterfront Revitalization

Prepared by T. Hart and N. Salafsky December 1989

# THE FUTURE OF THE RIVER

## Unique Values of Hudson River Habitats

One might question the rationale in any endeavor to conserve natural areas. One answer with regard to protection of the Hudson River's tidal habitats in New York is that it is the law. Virtually all the habitats described in this guide are protected under the provisions of federal and state laws dealing with water quality, endangered species, coastal management, wetland protection and significant habitats. Laws are only effective, however, if people understand and respect them and work to implement and enforce them. Ultimately, only public understanding of the unique values of the habitats along the Hudson River will ensure their continued survival. This natural resources guide has attempted to present enough information about these habitats so that it will be easier for interested groups and citizens to develop the understanding and sense of partnership necessary for effective protection of the River's resources.

In attempting to summarize the ideas and information contained in the preceding chapters, there is an overwhelming temptation to try to anticipate which information will be the most important or useful. Initially, it seems likely that specific site information may be used most often because of local interests reflecting local government boundaries, or perhaps because of the site specific nature of proposals which may threaten the ecological value of specific habitats. But many questions must be answered for each specific site before one can evaluate the relative significance of a proposed project or activity in terms of its impacts upon the characteristics and quality of a specific habitat. In some instances, understanding the biology of an endangered or otherwise valuable species will be more important than site specific information and will override all other concerns. In other instances, the more subtle nature of the interaction among ecological zones and the animals and plants that participate in and depend on these interactions will be the most valuable aspect of the habitat. Ultimately, no particular part of this guide will prevail over the others for one simple reason: the subject of this guide, the Hudson River, is an ecosystem. Each component of that ecosystem described in this guide is an integral part of the River as an entity.

In considering the River as an ecosystem, two themes emerged during the preparation of this guide that pervaded all aspects of human use and conservation of the Hudson. It seems fitting to close with a discussion of these two ideas.

## Borrowing from our Children

*We do not inherit the earth, we borrow it from our children.*

--Amish Saying

Over time, the natural resources of the Hudson have been regarded in several different ways. The first European settlers saw the valley as an untamed wilderness that represented a challenge and opportuntity for them to transform. Soon after, however, the large trading companies sought to extract as much wealth as possible for both personal and national profit. For several centuries, the River valley continued to serve as a wellspring of natural resources with its supply of fish, water, building materials, and other commodities limited only by human technology and demand.

As the Hudson Valley's population increased, its natural resources began to dwindle. In the eighteenth century, the beavers and other furbearing animals became locally scarce or extinct. The hemlocks that provided the basis for the leather tanning industry disappeared in the nineteenth century as did the once thriving shellfish beds in Haverstraw Bay. In the first half of the twentieth century, commercial fishing declined rapidly as fish stocks dwindled. More recently, contaminants have reduced the value of the River's resources. Today, even water supply may become scarce with many different demands being placed upon it.

A basic economic principle is that as resources become scarcer, their value increases unless substitutes are found. With regard to beaver pelts, hemlock bark, or even fish, substitutes can be found or the need for the use of the resource eliminated. But today, the scarcity of resources becomes more pressing. Imagine, for example, the City of Poughkeepsie having to find an alternative water supply and the cost associated with such an undertaking. Clearly, if we are to be successful in preserving the River ecosystem for its plants, animals, and people, we can no longer view the Hudson River as a boundless resource. Instead, it is necessary to adopt policies that recognize resource limitations, even among resources that are now considered renewable. In accordance with economic practice, it is logical to ask consumers of these limited resources to pay for them.

Disposal of toxic wastes provides a good illustration of this principle. Until the 1970's, producers of toxic wastes were allowed to pollute air, water, and land as a right of ownership. The environmental movement started with the realization that pollution often dramatically affected the lives of people who were close to and even distant from the source of pollution. Beginning with air, and later, water and land resources, government responded with laws that acknowledge these as public resources that must be protected and preserved in the public interest. It is no longer an assumed right to pollute these resources.

There has been a tremendous change in the protection of the Hudson River's resources over the past twenty years. The anoxic, open cesspools of summer are gone from the upper River, fishery resources are at healthy levels, wetland filling has been reduced, and birds of prey have returned to the River. Much more needs to be done. This requires further public recognition that the right to alter a habitat or to discharge pollutants is granted by the public who must be compensated for the use of the resource. In effect, this policy captures the full cost of developing land or producing a given product, including the expense of safely disposing of waste products.

For example, the SPDES program limits the quantity of toxic compounds that can be discharged into the River basin. It is not difficult to imagine moving from the present structure of the SPDES program, which is based on voluntary or self-regulated compliance, to more stringent regulation and enforcement. Funds for stricter enforcement could come from fees levied on dischargers who utilize the public resource of the River water for private profit. Precedents exist for having private users pay for use of public resources. The best known example on the Hudson is Exxon Corporation's payment, under threat of suit by the Hudson Riverkeeper of two million dollars to the Riverkeeper Fund and New York State, for using tankers to transport fresh water from the River to the Caribbean island of Aruba.

Beginning with estsablished precedents, and based on the principle that the River's resources belong to the public, it is possible to effectively protect all the resources of the River. Permission for municipalities to withdraw water can be linked to effective conservation measures. Permission for shipping companies to use the River for transportation can be linked to fees covering the true costs of dredging the channel and environmental impacts of using the River. And permission to discharge toxic contaminants can only be allowed when the true cost to the resource and public health is compensated. When the resources of the River are seen as public domain, they can be effectively used for the plants, animals, and people of both today--and of tomorrow.

## Because They Could Do Only a Little

Nobody makes a greater mistake than he who did nothing because he could do only a little.

--Edmund Burke

In considering the complex nature of the Hudson River ecosystem, it is apparent that a wide range of environmental protection and management actions must be taken if the ecosystem's natural resource values are to be preserved. The magnitude of problems and challenges involved requires solutions at many different levels. Examples of actions that could be taken by various agencies, concerned individuals and organizations, are outlined below.

**Legislators** can work to protect tidal habitats by improving existing laws and regulations and promulgating new measures at both Federal and State levels. One important action would be to extend the coverage of the Tidal Wetlands Act from its present limit at the Tappan Zee Bridge farther upstream to cover all tidal portions of the Hudson River and its tributaries up to the dam at Troy. This extension would increase the buffer zone surrounding wetlands from 100 to 300 feet (or the 10 foot elevation contour) and also provide for more comprehensive treatment of wetlands. Another step would be to amend the Reservoir Release Law (Art. 15, Title 8) so that sufficient water is released into the River not only to support drinking water and recreational needs, but also to meet instream needs for plants and animals in tidal habitats. Laws could also be enacted to create a system to compensate the public for the use of the River's public resources.

Existing and new laws protecting habitats are useless without effective enforcement by **government agencies** which need adequate support, funding, and commitment to carry out their responsibilities. In enforcing laws, it is critical that a distinction be made between the theory and practice of environmental protection. For example, although measures to reduce impacts from dredging may be written into a work contract, the value of these measures ultimately depends on the dredging contractor's compliance with conditions designed to protect the environment. Compliance with conditions depends on clear explanations which provide sound reasoning for each condition and an effective inspection and enforcement procedure, which could include financial incentives that favor compliance with conditions.

**Conservation organizations** also play an important role in protection and management of the River's public resources. These organizations can often improve government decision-making, particularly in the case of permit approvals, by providing valuable resource information and commentary, usually through existing public notice procedures. Indeed, the level of expertise available through these organizations, in combination with their commitment to protection of resources, is an essential component of the River's resource protection network. These organizations can also effectively lobby legislators to pass new laws and to appropriate sufficient funds for implementation of existing laws. Furthermore, conservation organizations are in the best position to monitor whether the public policy expressed in law is being adequately implemented by the responsible agency.

In similar fashion, **local governments** are invaluable in the protection of their sections of the River. Local governments can and do rely on higher levels of government for natural resource protection. All too often however, the first-hand knowledge and views of local governments are not sufficiently factored into resource protection decisions by State and Federal authorities. The ability of local government to protect valuable natural resources under its jurisdiction may be even more important. Local governments have the ability and the obligation to protect their citizens and the public resources that are valuable to the community, including natural resources. Through use of police powers, such as zoning and subdivision approval, and through the implementation of special laws such as the State Environmental Quality Review Act and the Waterfront Revitalization and Coastal Resources Act, many communities are in the strongest position of any level of government to protect valuable natural resources.

And last, but most importantly, **concerned citizens** are the key to the entire process. It is they who can lobby legislators to pass crucial laws and who can demand that government officials and private organizations they support serve as protectors of the public interest.

*Give light and the people will find their own way.*

\- Dante

The intent in preparing this guide to natural resource protection is to shed stronger light to help concerned people become more involved in protection of the River's tidal habitats. This guide cannot be an endpoint; it only represents a small step forward in a journey that must be taken if the resources of the River are to be protected and preserved, not only for our children, but for everyone's benefit and enjoyment, today and tomorrow.

# APPENDICES

## APPENDIX A: PLANT SPECIES REFERENCED IN THE TEXT

This is not a complete list of plants found in and around the estuarine portion of the Hudson River. This list provides scientific names for plants referenced in the text in order to avoid confusion from the use of common names. Scientific and common names follow Mitchell (1986).

| COMMON NAME | SCIENTIFIC NAME |
|---|---|
| **Spleenwort Family** | ***Aspleniaceae*** |
| Sensitive fern | *Onoclea sensibilis* |
| Marsh fern | *Thelypteris palustris* |
| **Laurel Family** | ***Lauraceae*** |
| Spicebush | *Lindera benzoin* |
| **Waterlily Family** | ***Nymphaeaceae*** |
| Spatterdock | *Nuphar luteum* |
| **Amaranth Family** | ***Amaranthaceae*** |
| Water-hemp | *Amaranthus cannabinus* |
| **Elm Family** | ***Ulmaceae*** |
| Slippery elm | *Ulmus rubra* |
| **Buckwheat Family** | ***Polygonaceae*** |
| Knotweeds | *Polygonum sp.* |
| Smartweeds | *Polygonum sp.* |
| **Mustard Family** | ***Brassicaceae*** |
| Pennsylvania bittercress | *Cardamine pennsylvanica* |
| **Sedum Family** | ***Crassulaceae*** |
| Pigmyweed | *Tillaea aquatica* |
| **Water milfoil Family** | ***Haloragaceae*** |
| Eurasian water milfoil | *Myriophyllum spicatum* |
| **Bean Family** | ***Fabaceae*** |
| Hog-peanut | *Amphicarpea bracteata* |
| **Loosestrife Family** | ***Lythraceae*** |
| Purple loosestrife | *Lythrum salicaria* |
| **Water-chestnut Family** | ***Trapaceae*** |
| Water-chestnut | *Trapa natans* |
| **Dogwood Family** | ***Cornaceae*** |
| Silky dogwood | *Cornus amomum* |
| **Grape Family** | ***Vitaceae*** |
| Virginia creeper | *Parthenocissus inserta* |
| **Maple Family** | ***Aceraceae*** |
| Red maple | *Acer rubrum* |
| **Sumac Family** | ***Anacardiaceae*** |
| Poison sumac | *Toxicodendron vernix* |

| | |
|---|---|
| **Touch-me-not Family** | ***Balsaminaceae*** |
| Spotted jewelweed | *Impatiens capensis* |
| **Milkweed Family** | ***Asclepiadaceae*** |
| Swamp milkweed | *Asclepias incarnata* |
| **Morning-glory Family** | ***Convolvulaceae*** |
| Common dodder | *Cuscuta gronovii* |
| **Plantain Family** | ***Plantaginaceae*** |
| Heart leaf plantain | *Plantago cordata* |
| **Olive Family** | ***Oleaceae*** |
| Black ash | *Fraxinus nigra* |
| Green ash | *F. pennsylvanica* |
| **Figwort Family** | ***Scrophulariaceae*** |
| Mudwort | *Limosella australis* |
| False-pimpernell | *Lindernia dubia* |
| Micranthemum | *Micranthemum micranthemoides* |
| Common monkeyflower | *Mimulus ringens* |
| Winged monkeyflower | *M. alatus* |
| Lousewort | *Pedicularis lanceolata* |
| **Bluebell Family** | ***Campanulaceae*** |
| Cardinal-flower | *Lobelia cardinalis* |
| **Honeysuckle Family** | ***Caprifoliaceae*** |
| Arrowwood | *Viburnum recognitum* |
| **Aster Family** | ***Asteraceae*** |
| Estuary beggar-ticks | *Bidens bidentoides* |
| Bur marigold | *Bidens sp. (cernua, laevis, etc.)* |
| Spotted Joe-pyeweed | *Eupatorium maculatum* |
| Sneezeweed | *Helenium autumnale* |
| **Water-plantain Family** | ***Alismataceae*** |
| Water-plantain | *Alisma plantago-aquatica* |
| Spongy arrowhead | *Sagittaria calycina var: spongiosa* |
| Grass-leaf arrowhead | *S. graminea* |
| Strap-leaf arrowhead | *S. subulata* |
| Big-leaved arrowhead | *S. latifolia* |
| **Frog's-bit Family** | ***Hydrocharitaceae*** |
| Waterweed | *Elodea canadensis* |
| Wild celery (tapegrass) | *Vallisneria americana* |
| **Pondweed Family** | ***Potamogetonaceae*** |
| Sago pondweed | *Potamogeton pectinatus* |
| Pondweed | *P. perfoliatus* |
| **Ditchgrass Family** | ***Ruppiaceae*** |
| Widgeon-grass (ditch grass) | *Ruppia maritima* |
| **Naiad Family** | ***Najadaceae*** |
| Naiad | *Najas guadalupensis var. muencheri* |
| Naiad | *N. minor* |

| | |
|---|---|
| **Horned pondweed Family** | ***Zannichelliaceae*** |
| Horned pondweed | *Zannichellia palustris* |
| **Eelgrass Family** | ***Zosteraceae*** |
| Eelgrass | *Zostera marina* |
| **Arum Family** | ***Araceae*** |
| Sweetflag | *Acorus americanus* |
| Golden club | *Orontium aquaticum* |
| Arrow arum (arrowleaf) | *Peltandra virginica* |
| Skunk cabbage | *Symplocarpus foetidus* |
| **Duckweed Family** | ***Lemnaceae*** |
| Duckweed | *Lemna minor* |
| **Hatpin Family** | ***Eriocaulaceae*** |
| Estuary hatpins | *Eriocaulon parkeri* |
| **Sedge Family** | ***Cyperaceae*** |
| Sedge | *Carex hormathodes* |
| River bulrush | *Scirpus fluviatilis* |
| Three-square | *S. americanus* |
| Saltmarsh bulrush | *S. cylindricus* |
| **Grass Family** | ***Poaceae*** |
| Rice cutgrass | *Leersia oryzoides* |
| Common reed | *Phragmites australis* |
| Cordgrass | *Spartina alterniflora* |
| Wild rice | *Zizania aquatica* |
| **Cat-tail Family** | ***Typhaceae*** |
| Narrow-leaf cat-tail | *Typha angustifolia* |
| Broad-leaf cat-tail | *Typha latifolia* |
| **Pickerel-weed Family** | ***Pontederiaceae*** |
| Pickerel-weed | *Pontederia cordata* |
| Mud-plantain | *Heteranthera reniformis* |

**APPENDIX B: ANIMAL SPECIES REFERENCED IN THE TEXT**

This is not a complete list of the animals found in and around the estuarine portion of the Hudson River. This list provides scientific names for animals referenced in the text in order to avoid confusion from the use of common names.

| COMMON NAME | SCIENTIFIC NAME |
|---|---|
| **Invertebrates** | |
| Bluecrab | *Callinectes sapidus* |
| | |
| **Fish** | **(after Smith, 1985)** |
| Sea lamprey | *Petromyzon marinus* |
| Shortnose sturgeon | *Acipenser brevirostrum* |
| Atlantic sturgeon | *A. oxyrhynchus* |
| American eel | *Anguilla rostrata* |
| Blueback herring | *Alosa aestivalis* |
| Hickory shad | *A. mediocris* |
| Alewife | *A. pseudoharengus* |
| American shad | *A. sapidissima* |
| Atlantic menhaden | *Brevoortia tyrannus* |
| Bay anchovy | *Anchoa mitchilli* |
| White catfish | *Ictalurus catus* |
| Brown bullhead | *I. nebulosus* |
| American goosefish | *Lophius americanus* |
| Atlantic tomcod | *Microgadus tomcod* |
| Goldfish | *Carassius auratus* |
| Carp | *Cyprinus carpio* |
| Silvery minnow | *Hybognathus regius* |
| Golden shiner | *Notemigonus crysoleucas* |
| Common shiner | *Notropis cornutus* |
| Spottail shiner | *N. hudsonius* |
| Rainbow smelt | *Osmerus mordax* |
| Banded killifish | *Fundulus diaphanus* |
| Mummichog | *F. heteroclitus* |
| Inland silverside | *Menidia beryllina* |
| White perch | *Morone americana* |
| Striped bass | *M. saxatilis* |
| Pumpkinseed | *Lepomis gibbosus* |
| Bluegill | *L. macrochirus* |
| Smallmouth bass | *Micropterus dolomieui* |
| Largemouth bass | *M. salmoides* |
| Tesselated darter | *Etheostoma olmstedi* |
| Yellow perch | *Perca flavescens* |
| Bluefish | *Pomatomus saltatrix* |
| Silver perch | *Bairdiella chrysoura* |
| Weakfish | *Cynoscion regalis* |
| Longhorn sculpin | *Myoxocephalus octodecemspinosus* |
| Hogchoker | *Trinectes maculatus* |
| | |
| **Reptiles and Amphibians** | **(after Conant, 1975)** |
| Common snapping turtle | *Chelydra serpentina* |
| Stinkpot | *Sternotherus odoratus* |
| Eastern mud turtle | *Kinosternon subrubrum* |
| Spotted turtle | *Clemmys guttata* |
| Bog turtle | *C. muhlenbergi* |
| Wood turtle | *C. insculpta* |
| Diamondback terrapin | *Malaclemys terrapin* |
| Map turtle | *Graptemys geographica* |
| Painted turtle | *Chrysemys picta* |

| | |
|---|---|
| Eastern box turtle | *Terrapene carolina* |
| Northern water snake | *Nerodia sipedon* |
| **Birds** | **(after Bull, 1974)** |
| Great blue heron | *Ardea herodias* |
| Great egret | *Casmerodius albus* |
| Green heron | *Butorides striatus* |
| Black-crowned night heron | *Nycticorax nycticorax* |
| American bittern | *Botaurus lentiginosus* |
| Least bittern | *Ixobrychus exilis* |
| Mute swan | *Cygnus olor* |
| Canada goose | *Branta canadensis* |
| Brant | *Branta bernicla* |
| Wood duck | *Aix sponsa* |
| Mallard | *Anas platyrhynchos* |
| Black duck | *A. rubripes* |
| Gadwall | *A. strepera* |
| Common pintail | *A. acuta* |
| Green-winged teal | *A. crecca* |
| Blue-winged teal | *A. discors* |
| Northern shoveler | *A. clypeata* |
| Canvasback | *Aythya valisineria* |
| Redhead | *A. americana* |
| Ring-necked duck | *A. collaris* |
| Greater scaup | *A. marila* |
| Lesser scaup | *A. affinis* |
| Common goldeneye | *Bucephala clangula* |
| Bufflehead | *B. albeola* |
| Oldsquaw | *Clangula hyemalis* |
| White-winged scoter | *Melanitta deglandi* |
| Surf scoter | *M. perpiscillata* |
| Black scoter | *Melanitta nigra* |
| Hooded merganser | *Laphodytes cucullatus* |
| Common merganser | *M. merganser* |
| Red-breasted merganser | *M. serrator* |
| Ruddy duck | *Oxyura jamaicensis* |
| Osprey | *Pandion haliaetus* |
| Bald eagle | *Haliaeetus leucocephalus* |
| Northern harrier | *Circus cyaneus* |
| Common bobwhite | *Colinus virginianus* |
| Gray partridge | *Perdix perdix* |
| Virginia rail | *Rallus limicola* |
| King rail | *R. elegans* |
| Common gallinule | *Gallinula chloropus* |
| Lesser golden plover | *Pluvialis dominica* |
| Piping plover | *Charadrius melodus* |
| Semipalmated plover | *C. semipalmatus* |
| Killdeer | *C. vociferous* |
| Common snipe | *Capella gallinago* |
| Spotted sandpiper | *Actitis macularia* |
| Belted kingfisher | *Megaceryle alcyon* |
| Long-billed marsh wren | *Cistothorus palustris* |
| Red-winged blackbird | *Agelaius phoeniceus* |
| Swamp sparrow | *Melospiza georgiana* |
| Song sparrow | *P. melodia* |
| Yellow warbler | *Dendroica petechia* |
| Willow flycatcher | *Empidonax traillii* |
| Common yellowthroat | *Geothylpis trichas* |
| American goldfinch | *Carduelis tristis* |

| | |
|---|---|
| Eastern kingbird | *Tyrannus tyrannus* |
| Gray catbird | *Dumetella carolinensis* |
| Common grackle | *Quiscalus quiscula* |
| **Mammals** | **(after Burt and Grossenheider, 1976)** |
| Racoon | *Procyon lotor* |
| Black bear | *Ursus americanus* |
| Longtail weasel | *Mustela frenata* |
| Mink | *M. vison* |
| Common striped skunk | *Mephitis mephitis* |
| Red fox | *Vulpes fulva* |
| Bobcat | *Lynx rufus* |
| Woodchuck | *Marmota monax* |
| Chipmunk | *Tamias striatus* |
| Eastern grey squirrel | *Sciurus carolinensis* |
| Muskrat | *Ondatra zibethica* |
| Beaver | *Castor canadensis* |
| Cottontail | *Sylvilagus floridanus* |
| Whitetail deer | *Odocoileus virginianus* |

# APPENDIX C: AGENCIES AND ORGANIZATIONS INVOLVED IN PROTECTION OF THE HUDSON RIVER'S RESOURCES

In this Appendix, addresses and phone numbers for the groups listed in Chapter 5 are given.

## Federal Agencies

**U.S. Army Corps of Engineers**
New York District
26 Federal Plaza
New York, NY 10278
(212) 264-4662

**U.S. Fish and Wildlife Service**
Northeast Region
One Gateway Center, Suite 700
Newton Corner, MA 02158
(617) 965-5100

**U.S. Environmental Protection Agency**

Headquarters
401 M Street, SW
WH-556F
Washington, DC 20460
(202) 382-7166

Region II
26 Federal Plaza
New York, NY 10278
(212) 264-5170

**National Oceanic and Atmospheric Administration Office of Ocean and Coastal Resource Management**
1825 Connecticut Ave. NW
Washington, DC 20235
(202) 673-5152

**National Park Service**
North Atlantic Regional Office
15 State St, 8th Fl.
Boston, MA 02109-3572
(617) 565-8800

**United States Geological Survey**
New York State District
PO Box 1397
Albany, NY 12201
(518) 472-3107

**USDA Soil Conservation Service**
100 S. Clinton St. Rm. 771
James M. Hanley Building
Syracuse, NY 13260

**New York State Government**

**New York Senate**
**Committee on Environmental Conservation**
State Capitol
Albany, NY 12224
(518) 455-2181

**New York Assembly**
**Committee on Environmental Conservation**
State Capitol
Legislative Office Bldg.
Albany, NY 12224
(518) 455-4436

**Department of Environmental Conservation**

Main Office
50 Wolf Road
Albany, NY 12233
(518) 457-6674

Hudson River Unit
21 South Putt Corners Road
New Paltz, NY 12561
(914) 255-5453

Region 3 Main office
21 South Putt Corners Road
New Paltz, NY 12561
(914) 255-5453

Region 3 Sub-office
202 Mamaroneck Ave.
White Plains, NY 10601
(914) 761-6660

Region 4 Main office
2176 Guilderland Ave.
Schenectady, NY 12306
(518) 382-0680

Region 4 Sub-office
Route 10, Jefferson Road
Stamford, NY 12167
(607) 652-7364

**Department of State**
**Division of Coastal Resources and Waterfront Revitalization**
162 Washington Ave.
Albany, NY 12231
(518) 474-6000

**Office of Parks, Recreation, and Historic Preservation**

Palisades Interstate Parks Commission
122 E. 42nd St.
New York, NY 10019
(914) 786-2701

Saratoga/Capital District Reg.
PO Box W
Saratoga Springs, NY 12866
(518) 584-2000

Taconic Region
Staatsburg, NY 12580
(914) 889-4100

**Hudson River National Estuarine Sanctuary Program**
Bard College Field Station
Annandale, NY 12504
(914) 758-5193

**New York Natural Heritage Program**
Wildlife Resource Center
Delmar, NY 12054-9767
(518) 439-7488

## County Agencies

**New York State Association of Environmental Management Councils**
65 Broad Street, Rm. 203
Rochester, NY 14614

**New York State Association of Conservation Commissions**
131 Big Island Road
Warwick, NY 10990

**Albany County**

Planning Board
1 Lodge St.
Albany, NY 12207
(518) 445-7964

Environmental Management Council
1 Lodge St.
Albany, NY 12207
(518) 445-7757

Soil and Water Conservation
RD 2, Martin Rd.
Voorheesville, NY 12186
(518) 765-2813

**Columbia County**

Development and Planning
Dept.
414 Union Street
Hudson, NY 12534
(518) 828-3375

Environmental Management
Council
414 Union Street
Hudson, NY 12534
(518) 828-3375

Soil and Water Conservation
813 Warren St.
Hudson, NY 12534
(518) 758-9265

**Dutchess County**

Planning Department
47 Cannon St.
Poughkeepsie, NY 12601
(914) 431-2480

Environmental Management
Council
PO Box 259
Farm and Home Center Rt 44
Millbrook, NY 12545
(914) 677-3488

Soil and Water Conservation
PO Box 37
Farm and Home Center Rt 44
Millbrook, NY 12545
(914) 677-8011

**Greene County**

Planning Department
Rt. 3, Box 909
Cairo, NY 12413
(518) 622-3251

Environmental Management
Council
Rt. 3, Box 909
Cairo, NY 12413
(518) 622-3251

Soil and Water Conservation
Route 23B, PO Box 104
So. Cairo, NY 12482
(518) 622-8587

**Orange County**

Department of Planning
124 Main Street
Goshen, NY 10924
(914) 294-5151

Environmental Control
Commission
Dunderberg Road
Central Valley, NY 10917
(914) 928-9441

Soil and Water Conservation
33 Fulton St.
Middletown, NY 10940
(914) 343-1873

**Putnam County**

Planning Board
RD 9, Box 331
Fair Street
Carmel, NY 10512
(914) 878-3480

Environmental Management
Council
RD 9, Box 331
Fair Street
Carmel, NY 10512
(914) 878-3480

**Rensselaer County**

Planning Board
1600 7th Ave.
Troy, NY 12180
(518) 270-2920

Environmental Management
Council
1600 7th Ave.
Troy, NY 12180
(518) 270-5386

Soil and Water Conservation
County Office Bldg.
Troy, NY 12180
(518) 270-2797

**Rockland County**

Planning Board
18 New Hempstead Road
New City, NY 10956
(914) 425-5472

Environmental Management Council
Building D, Rm. 147
Health Complex, Sanitarium Rd.
Pomona, NY 10970
(914) 354-0200 Ext. 2468

Soil and Water Conservation
23 Hempstead Road
New City, NY 10956
(914) 425-5084

**Ulster County**

Planning Board
244 Fair St.
Kingston, NY 12401
(914) 331-9300

Environmental Management Council
244 Fair St.
Kingston, NY 12401
(914) 331-9300

Soil and Water Conservation
380 Washington Ave
UPO Box 97
Kingston, NY 12401
(914) 338-4764

**Westchester County**

Planning Department
148 Martine Ave.
County Office Bldg.
White Plains, NY 10601
(914) 682-2502

Environmental Management Council
412 County Office Bldg.
White Plains, NY 10601
(914) 682-7610

Soil and Water Conservation
216 Central Ave.
White Plains, NY 10606
(914) 683-6772

**Municipal Agencies**
Consult town, village or city offices

**Private Organizations**

**The Nature Conservancy**

New York Field Office
1736 Western Ave.
Albany, NY 12203
(518) 869-6959

Eastern New York Chapter
1736 Western Ave.
Albany, NY 12203
(518) 869-0453

Lower Hudson Chapter
223 Katonah Avenue
Katonah, NY 10536
(914) 232-9431

**National Audubon Society**

Northeast Regional Office
1789 Western Ave.
Albany, NY 12203
(518) 869-9731

Constitution Marsh Sanctuary
RFD 2, Route 9D
Garrison, NY 10524
(914) 265-3119

**Natural Resources Defense Council**
122 E 42nd St.
New York, NY 10168
(212) 949-0049

**The Sierra Club**
Atlantic Chapter
234 Hudson Ave
PO Box 2112 E SP Station
Albany, NY 12220
(518) 472-1534

**Scenic Hudson**
9 Vassar Street
Poughkeepsie, NY 12601
(914) 473-4440

**Clearwater**
112 Market Street
Poughkeepsie, NY 12601
(914) 454-7673

**Audubon Society of New York**
8 Wade Rd.
Latham, NY 12110
(518) 783-8587

**Ducks Unlimited**
River Rd. RD 2, Box 225
Hamilton, NY 13346
(315) 691-3167

**Hudson River Foundation**
122 East 42 Street, Suite 1901
New York, NY 10168
(212) 949-0028

**Hudson Riverkeeper Fund**
P.O. Box 130
Garrison, NY 10524
(914) 424-4149

**Hudsonia**
Bard College Field Station
Annandale, NY 12504
(914) 758-1881

**Institute for Ecosystem Studies**
Cary Arboretum
Box AB
Millbrook, NY 12545
(914) 677-5343

**Ecosystems Research Center**
Cornell University
Corson Hall
Ithaca, NY 14853
(607) 255-4348

**Museum of the Hudson Highlands**
PO Box 181
The Boulevard
Cornwall, NY 12520
(914) 534-7781

Allen, A.
1986 Habitat Suitability Index Models: Mink. U.S. Fish and Wildlife Service Biological Report. FWS/OBS 82/10.127. 23 pp.

Bain, M. and J. Bain
1982 Habitat Suitability Index Models: Coastal Stocks of Striped Bass. U.S. Fish and Wildlife Service Biological Report. FWS/OBS-82/10.1. 29 pp.

Barclay, B.
1988 Competing Demands: Instream and Out of Stream Needs. Presented at "Water Resources in New York State: Supplies, Demands, and Expenses." Clearwater, Poughkeepsie, NY.
1989 Comments on draft of this manuscript.

Bellrose, F.
1976 Ducks, Geese, and Swans of North America. Wildlife Management Institute, Washington, DC. 540 pp.

Bender, J.
1986 Element Stewardship Abstract: Heartleaf Plantain. The Nature Conservancy, Midwest Regional Office, Minneapolis, MN. 15 pp.

Boyce Thompson Institute
1977 An Atlas of the Biological Resources of the Hudson River Estuary. Estuarine Study Group, Boyce Thompson Institute for Plant Research, Ithaca, NY. 104 pp.

Boyle, R.
1979 The Hudson River: A Natural and Unnatural History. W.W. Norton, New York, NY. 325 pp.

Bull, J.
1985 Birds of New York State. Cornell University Press, Ithaca, NY. 703 pp.

Burt, W. and R. Grossenheider
1976 A Field Guide to the Mammals, 3rd ed. Houghton Mifflin Co., Boston, MA. 289 pp.

Chabbra, V.
1988 Hudson's Edible Jewels. Albany Times Union, Aug. 23, p. C-1.

Chesapeake Bay Program
1987 Habitat Requirements for Chesapeake Bay Living Resources. Chesapeake Bay Living Resources Task Force, Annapolis, MD. 86 pp.

Clearwater
1979 A Panoramic View of the Hudson. Clearwater, Inc., Poughkeepsie, NY.

Cole, J.
1989 Nutrient Dynamics and Phytoplankton Production in the Lower Estuary. Presentation at the annual Hudson River Foundation Symposium

Conant, R.
1975 A Field Guide to Reptiles and Amphibians of Eastern/Central North America. Houghton Mifflin, Boston, MA. 429 pp.

Cowardin, L., V. Carter, F. Golet, and E. Laroe
1979 Classification of Wetlands and Deepwater Habitats of the United States. U.S. Fish and Wildlife Service Biological Service Report. FWS/OBS-79/31. 103 pp.

Crance, J.
1984 Habitat Suitability Index Models and Instream Flow Suitability Curves: Inland Stocks of Striped Bass. U.S. Fish and Wildlife Service Biological Report FWS/OBS-82/10.85. 63 pp.
1986 Habitat Suitability Index Models and Instream Flow Suitability Curves: Shortnose Sturgeon. U.S. Fish and Wildlife Service Biological Report FWS/OBS-82/10.129. 31 pp.

Daiber, F.
1986 Conservation of Tidal Marshes. Van Nostrand Reinhold, New York, NY. 341 pp.

DEC (New York State Department of Environmental Conservation)
Undated. List of Endangered, Threatened, and Special Concern Species of New York State. NYSDEC, Delmar, NY.
1988 Fishing, Small Game Hunting, and Trapping: Regulations Guide.

Decker, D. and J. Enck (eds)
1987 Exotic Plants with Identified Detrimental Impacts on Wildlife Habitats in New York State. The Exotic Plant Committee of the New York Chapter-The Wildlife Society, Ithaca, NY. 57 pp.

DeGraaf, R. and D. Rudis
1986 New England Wildlife: Habitat, Natural History, and Distribution. U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station, General Technical Report NE-108, Broomall, PA. 401 pp.

Dieffenbacher-Krall, J.
1986 Comments on Proposed Recommendations for Recreational Striped Bass Management in New York State. Environmental Planning Lobby, Albany, NY. 4 pp.

DOS (New York State, Department of State)
1987a Local Government Handbook, 4th ed. DOS, Albany, NY. 322 pp.
1987b Significant Coastal Fish and Wildlife Habitat: Project Narratives. DOS, Albany, NY.

Dovel, W.
1978 Sturgeons of the Hudson River. Boyce Thompson Institute for Plant Research, Ithaca, NY. 165+ pp.
1981 The Endangered Shortnose Sturgeon of the Hudson Estuary: Its Life History and Vulnerability to the Activities of Man. The Oceanic Society, Stamford, CT. 139 pp.

Dullea, H.
1985 Memorandum to Mario Cuomo on Striped Bass and PCBs.

Dunwell, F.
1984 Hudson River Estuary Fishery Management Program: Progress Report for 1982-1984. NYSDEC, New Paltz, NY. 45 pp.

Dyson, J.
1968 Our Historic Hudson. James B. Adler, New York, NY. 109 pp.

Fay, C., R. Neves, and G. Pardue
1983 Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates: Alewife/Blueback Herring. U.S. Fish and Wildlife Service, Division of Biological Services, FWS/OBS-82/11.9. 25 pp.

Fikslin, T. and J. Golumbek
1979 Population Dynamics of the Atlantic Tomcod in the Hudson River Estuary. Energy and Thermal Wastes Section, Water Division, U.S. EPA, Region II, New York, NY. 27 pp.

Firestone, D. and F. Reed
1983 Environmental Law for Non-Lawyers. Ann Arbor Science, Ann Arbor, MI. 282 pp.

Fisher, J., R. Perdue, M. Overton, M. Sobsey, and B. Still
1987 A Comparison of Water Quality at Two Recreational Marinas during a Peak-Use Period. University of North Carolina Sea Grant Publication UNC-WP-87-1. 46 pp.

Fletcher, R.
1984 A Survey and Analysis of Fish Conservation Devices for Water-Pumping Facilities Having High Volumetric Rates of Intake. Hudson River Foundation, New York, NY. 68+ pp.

Freedman, W.
1987 Federal Statutes on Environmental Protection. Quorum Books. New York, NY. 174 pp.

Frey, R. and P. Basan
1978 Coastal Salt Marshes. Pp. 101-169 in R. Davis,(ed.) Coastal Sedimentary Environments. Springer-Verlag, New York, NY.

Garritt, H.
1989 The Metabolism of a Submersed Macrophyte Community in the Tidal Fresh Water Hudson River Estuary. Exhibit at the annual Hudson River Foundation Symposium.

Gerrard, J., P. Gerrard, G. Bortolotti, and D. Whitfield
1983 A 14-year study of Bald Eagle Reproduction on Besnard Lake, Saskatchewan. Pp. 35-46 in D. Bird (ed.) Biology and Management of Bald Eagles and Ospreys. Harpell Press, Ste. Anne de Bellevue, QU. 325 pp.

Gleason, H.
1952 Illustrated Flora of the Northeastern United States and Adjacent Canada. Hafner Press, New York, NY. 3 vol.

Godfrey, P., E. Kaynor, S. Pelczarski, and J. Benforado (eds).
1985 Ecological Considerations in Wetlands Treatment of Municipal Wastewaters. Van Nostrand Reinhold Co, New York, NY. 474 pp.

Gorski, S.
1988 Letter to J Seebode, October 22, 1988.

Grant, R. and R. Patrick
1970 Tinicum Marsh as a Water Purifier. Pp. 105-123 in Two Studies of Tinicum Marsh, Conservation Foundation, Washington, DC.

Greene, E., A. Greene, and B. Freedman
1983 Foraging Behavior and Prey Selection by Ospreys. Pp. 257-268 in D. Bird (ed.) Biology and Management of Bald Eagles and Ospreys. Harpell Press, Ste. Anne de Bellevue, QU. 325 pp.

Grier, J.
1983 Trends in Bald Eagle Reproduction and Toxicants in Northwestern Ontario, Canada, 1966-81(Abstr.). Pp. 319 in D. Bird (ed.) Biology and Management of Bald Eagles and Ospreys. Harpell Press, Ste. Anne de Bellevue, QU. 325 pp.

Hall, A.
1978 The Hudson: That River's Alive. National Geographic, 153(Jan): 62-89.

Hammer, D. and R. Kadlec
1983 Design Principles for Wetland Treatment Systems. U.S. Environmental Protection Report EPA-600/2-83-026, Ada, OK. 244 pp.

Hancock, J. and J. Kushlan
1984 The Herons Handbook. Harper and Row, New York, NY. 288 pp.

Hawkins, P. and C. Leck
1977 Breeding Bird Communities in a Tidal Freshwater Marsh. Bull. NJ Acad. of Sci. 22: 12-17.

Hazen G. and Sawyer, P.
1987 Delaware-Lower Hudson Region: Water Resources Management Study, draft. NYSDEC, Albany, NY.

Henny, C.
1983 Distribution and Abundance of Nesting Ospreys in the United States. Pp. 175-186 in D. Bird (ed.) Biology and Management of Bald Eagles and Ospreys. Harpell Press, Ste. Anne de Bellevue, QU. 325 pp.

Horn, E. and L. Skinner
1985 Final Environmental Impact Statement for Policy on Contaminants in Fish. NYSDEC, Division of Fish and Wildlife, Albany, NY. 150 pp.

Hudson River Access Forum
1989 Between the Railroad and the River. Heritage Task Force, Poughkeepsie, NY. 123pp.

Hudson River Basin Study Group
1979a The Water and Related Land Resources of the Hudson River Basin. Draft Level B Study Report and Environmental Impact Report. NYS DEC, Albany, NY. 148 pp.
1979b Hudson River Basin Water and Land Resources Study: Selected Background Information. Vols. 1 & 2. NYS DEC, Albany, NY. 585 pp.

Hudson River Research Council
1980 Results of Hudson River Field Weeks April 1977 and August 1978. Water Temperature, Conductivity, Dissolved Oxygen, and Total Suspended Solids at Spring High Flow and Summer Low Flow. Hudson River Resource Council, Bronx, NY. 50 pp.

Hynes, H.
1970 The Ecology of Running Waters. University of Toronto Press, 555 pp.

Johnston, S. and R. Schmidt
1983 Polluting the Hudson: A Gentleman's Agreement: A Report on the SPDES Permit Program for the Period October 1979-September 1981. Hudson River Sloop Clearwater, Poughkeepsie, NY. 82+ pp.

Kadlec, R.
1978 Wetland for Tertiary Treatment. Pp. 490-504 in P. Greeson, J. Clark, and J. Clark (eds.) Wetland Functions and Values: The State of Our Understanding. American Water Resources Association, Minneapolis, MN.

Kiviat, E.
1978 Hudson River East Bank Natural Areas, Clermont to Norrie. The Nature Conservancy, Arlington, VA. 115p.
1979 Hudson Estuary Shore Zone: Ecology and Management. Unpublished Master's Thesis, State University College at New Paltz, NY. 159 pp.
1987a Common reed (*Phragmites australis*). Pp. 22-30 in D. Decker and J. Enck (eds.) Exotic Plants with Identified Detrimental Impacts on Wildlife Habitats in New York State. The Exotic Plant Committee of the New York Chapter-The Wildlife Society, Ithaca, NY. 57 pp.
1987b Water chestnut (*Trapa natans*). Pp. 31-38 in D.J. Decker and J.W. Enck (eds) Exotic Plants with Identified Detrimental Impacts on Wildlife Habitats in New York State. The Exotic Plant Committee of the New York Chapter-The Wildlife Society, Ithaca, NY. 57 pp.

Kusler, J.
1978 Strengthening State Wetland Regulations. U.S. Fish and Wildlife Service FWS/OBS-78/98 147 pp.

Limburg, K.
1985 PCBs in the Hudson. Pp. 116-182 in K. Limburg, M. Moran, and W. McDowell (eds.) Environmental Impact Assessment of the Hudson River Ecosystem. Ecosystems Research Center, Ithaca, NY.

Malecki, R.
1987 Purple loosestrife (*Lytherum salicaria*). Pp. 39-45 in D. Decker and J. Enck (eds.) Exotic Plants with Identified Detrimental Impacts on Wildlife Habitats in New York State. The Exotic Plant Committee of the New York Chapter-The Wildlife Society, Ithaca, NY. 57 pp.

McDowell, W.
1985 Power Plant Operation on the Hudson River. Pp. 56-115 in K. Limburg, M. Moran, and W. McDowell (eds.) Environmental Impact Assessment of the Hudson River Ecosystem. Ecosystems Research Center, Ithaca, NY 458pp.

Mildner, D.
1988 Personal communication with Nick Salafsky (TNC).

Mitchell, R.
1986 A Checklist of New York State Plants. Bulletin No. 458 of the New York State Museum, Albany, NY. 272 pp.

Mitsch, W. and J. Gosselink
1987 Wetlands. Van Nostrand Reinhold Co, New York, NY. 537 pp.

Moran, M. and K. Limburg
1985 The Hudson River Ecosystem. Pp. 8-55 in K. Limburg, M. Moran, and W. McDowell (eds.) Environmental Impact Assessment of the Hudson River Ecosystem. Ecosystems Research Center, Ithaca, NY. 458 pp.

Moran, M., P. Walczak, and K. Limburg
1985 Hudson River Data Base Pp. 239-302 in K. Limburg, M. Moran, and W. McDowell (eds.) Environmental Impact Assessment of the Hudson River Ecosystem. Ecosystems Research Center, Ithaca, NY. 458 pp.

MPI (Malcolm Pirnie, Inc.)
1983 Hudson River Federal Channel Maintenance Dredging Final Environmental Impact Statement. Vols. 1 and 2. Department of the Army New York District Corps of Engineers New York District, New York, NY.

Mylod, J.
1969 Biography of a River: The Peoples and Legends of the Hudson Valley. Bonanza Books, New York, NY. 244pp.
1987 Letter to Henry Williams, DEC Commissioner on Amending the Striped Bass Regulations. Clearwater, Poughkeepsie, NY. 5 pp.

Newcomb, L.
1977 Newcomb's Wildflower Guide. Little, Brown, and Co., Boston, MA. 490 pp.

NOAA (National Oceanic and Atmospheric Administration)
1988 Tide Tables 1988, High and Low Water Predictions: East Coast of North and South America Including Greenland. National Ocean Service, Riverdale, MD. 289 pp.

Nye, P. and L. Surling
1978 Observations Concerning a Wintering Population of Bald Eagles on an Area in Southeastern New York. NY Fish and Game J. 25(2): 91-107.

Oceanic Society
1980 Hudson River Fishery Management Program Study. Unpublished report to the NYS DEC.

Odum, H.
1978 Value of Wetlands as Domestic Ecosytems. Pp. 9-18 in J. Montanari and J. Kusler (eds.) National Wetland Protection Symposium Proceedings, US Fish and Wildlife Service Biological Report FWS/OBS-78/97

Odum, W., T. Smith, J. Hoover, and C. McIvor
1984 The Ecology of Tidal Freshwater Marshes of the United States East Coast: A Community Profile. U.S. Fish and Wildlife Service Biological Report FWS/OBS-83/17. 177 pp.

Ogawa, H. and J. Male
1983 The Flood Mitigation Potential of Inland Wetlands, Water Resources Research Center Publication No. 138, University of Massachusetts, Amherst, MA. 164 pp.

Pardue, G.
1983 Habitat Suitability Index Models: Alewife and Blueback Herring. U.S. Fish and Wildlife Service Biological Report FWS/OBS-82/10.58. 22 pp.

Peterson, A.
1986 Habitat Suitability Index Models: Bald Eagle (Breeding Season). U.S. Fish and Wildlife Service Biological Report FWS/OBS-82/10.126. 25 pp.

Peterson, R.
1980 A Field Guide to the Birds East of the Rockies, 4th ed. Houghton Mifflin Co., Boston, MA. 384 pp.

Rawinski, T.
1988 Personal communication with Nick Salafsky (TNC).

Reschke, C.
1988 Natural and Cultural Ecological Communities of New York State, Preliminary Draft #4. New York Natural Heritage Program, Delmar, NY.

Rohmann, S.
1985 Tracing a River's Toxic Pollution: A Case Study of the Hudson. Inform: New York, NY. 154 pp.

Rohmann, S. and N. Lilienthal
1987 Tracing a River's Toxic Pollution: A Case Study of the Hudson, Phase II. Inform: New York, NY. 209 pp.

Ross, N.
1986 Environmental Impacts of Marinas and their Boats. Unpublished paper from Profitable Marina and Boatyard Management Seminar, University of Rhode Island. 9 pp.

Sanderson, G.
1976 Conservation of Waterfowl. Pp. 43-58 in F. Bellrose, Ducks, Geese, and Swans of North America. Wildlife Management Institute, Washington, DC. 540 pp.

Schaadt C. and L. Rymon
1983 The Restoration of Ospreys by Hacking. Pp. 299-305 in D. Bird (ed.) Biology and Management of Bald Eagles and Ospreys. Harpell Press, Ste. Anne de Bellevue, QU. 325 pp.

Scheller, W.
1988 The Hudson River Valley. American Geography Publishing, Helena, MT. 103 pp.

Seeger, P.
1988 Pulling Water Weeds: Letter to the Editor. Albany Times-Union, August 9.

Sheppard, J.
1976 Valuation of the Hudson River Fishery Resources: Past, Present, and Future. NYS DEC, Albany, NY. 51 pp.

Short H., and R. Cooper
1985 Habitat Suitability Index Models: Great Blue Heron. U.S. Fish and Wildlife Service Biological Report FWS/OBS-82/10.99. 23 pp.

Simpson, R., R. Good, M. Leck, and D. Whigham
1983 The Ecology of Freshwater Tidal Wetlands. BioScience 33: 255-259.

Sloan, R. and E. Horn
1985 PCB in Striped Bass from the Marine District of New York. NYS DEC, Albany, NY. 10 pp.

Smith, C.
1985 The Inland Fishes of New York State. NYS DEC, Albany, NY. 522 pp.

Smith, H.
1978 An Introduction to Habitat Development on Dredged Material. U.S. Army Corps of Engineers Dredged Material Res. Prog. Tech. Rept. DS-78-19, 37 pp.

Spitzer, P., A. Poole, and M. Scheibel
1983 Initial Population Recovery of Breeding Ospreys in the Region Between New York City and Boston. Pp. 257-268 in DM Bird (chief ed.) Biology and Management of Bald Eagles and Ospreys. Harpell Press, Ste. Anne de Bellevue, QU. 325 pp.

Stearns, F.
1978 Management Potential: Summary and Recommendations. Pp. 357-363 in R. Good, D. Whigham, and R. Simpson (eds.) Freshwater Wetlands: Ecological Processes and Management Potential. Academic Press, New York, NY.

Striped Bass Task Force
1984 Report to the Governor. NYS Department of Commerce, Albany, NY. 99+ pp.

Swift, B.
1987 An Analysis of Avian Breeding Habitats in Hudson River Tidal Marshes. NYS DEC, Delmar, NY. 62+ pp.

Tiner, R.
1985a Wetlands of Delaware. U.S. Fish and Wildlife Service, National Wetlands Inventory, Newton Corner, MA.
1985b Wetlands of New Jersey. U.S. Fish and Wildlife Service, National Wetlands Inventory, Newton Corner, MA.
1987 A Field Guide to Coastal Wetland Plants of the Northeastern United States. University of Massachusetts, Amherst, MA. 285 pp.

US Army Corps of Engineers
1972 Charles River Watershed, Massachusetts. New England Division, Waltham, MA. 65 pp.
1988 Draft Environmental Assessment: Maintenance Dredging of the Hudson River Federal Channel. New York District, New York, NY. 15 pp.

US Environmental Protection Agency
1983 Freshwater Wetlands for Wastewater Management: Environmental Impact Statement-Phase I Report. EPA 904/9-83-107, U.S. EPA Region IV, Atlanta, GA. 380 pp.
1985 Coastal Marinas Assessment Handbook. EPA 904/6-85-132, U.S. EPA Region 4, Atlanta, GA.
1987 Guide to Nonpoint Source Pollution Control. US EPA, Criteria and Standards Division, Washington, DC. 121pp.

US Office of Coastal Zone Management
1982 Final Environmental Impact Statement: Hudson River Estuarine Sanctuary. U.S. Office of Coastal Zone Management, Washington D.C. 343 pp.

Van Zandt, R.
1971 Chronicles of the Hudson: Three Centuries of Travelers' Accounts. Rutgers University, New Brunswick, NJ. 369 pp.

Vogl, R.
1973 Effects of Fire on the Plants and Animals of a Florida Wetland. Am. Midl. Nat. 89:334-347.

Walczak, P., M. Moran, J. Buckley, E. Buckley, and K. Limburg
1985 Hudson River Bibliography Pp. 303-458 in K. Limburg, M. Moran, and W. McDowell (eds) Environmental Impact Assessment of the Hudson River Ecosystem. Ecosystems Research Center, Ithaca, NY. 458 pp.

Weinstein, L. (ed)
1977 An Atlas of the Biologic Resources of the Hudson Estuary. Boyce Thompson Institute, Ithaca, NY. 105 pp.

Werner, R.
1980 Freshwater Fishes of New York State: A Field Guide. Syracuse University Press, Syracuse, NY. 186 pp.

Westad, K. and E. Kiviat
1986 Flora of Freshwater Tidal Swamps at Tivoli Bays, Hudson River National Estuarine Sanctuary. Bard College Field Station-Hudsonia Contribution No. 44. 20 pp.

Wetzel, R.
1975 Limnology. W.B. Saunders Co. Philadelphia, PA. 743 pp.

Whigham, D., J. McCormick, R. Good, and R. Simpson
1978 Biomass and Primary Production in Freshwater Tidal Marshes of the Middle Atlantic Coast. Pp. 3-20 in R. Good, D. Whigham, and R. Simpson (eds.) Freshwater Wetlands: Ecological Processes and Management Potential. Academic Press, New York, NY.

Whigham, D., R. Simpson, and K. Lee
1980 The Effect of Sewage Effluent on the Structure and Function of a Freshwater Tidal Wetland. Water Resources Research Institute Report, Rutgers University, New Brunswick, NJ. 160 pp.